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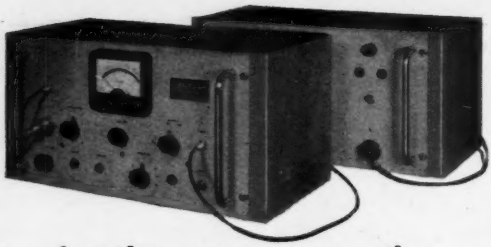

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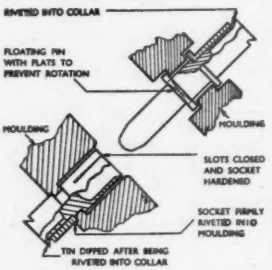
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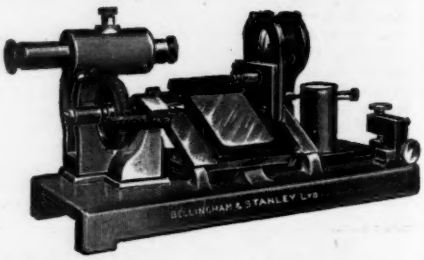

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SCIENCE AND TECHNOLOGY IN DEFENCE

THE recently issued Statement on Defence* is largely a progress report on what has been done in Britain to translate into a defence programme the policy outlined in last year's White Paper. Although during the summer of 1955 there was reason for hoping for a genuine relaxation in international tensions and for the growth of tolerance and understanding between the nations of the free world and those under Communist control, this hope has been disappointed. It remains necessary for the Western democracies to maintain their defensive strength until such time as a true understanding of Western policies can make its impact on the Soviet people.

The appreciation of the economic factors given in the White Paper is realistic and does at least point to the fundamental question: How much can Britain afford to spend on defence? It is not simply the effect of high expenditure on defence on the general level of taxation. Production for defence falls in the main upon the metal and metal-using industries, which supply about half the exports of Britain and are of great importance in re-equipping British industry, thus playing a vital part in strengthening the balance of payments. Moreover, the maintenance of British forces overseas involves a heavy direct charge on the balance of payments.

It is something to find at last frank acknowledgment that the claims of defence research must be balanced against the competing claims on the limited resources of scientific man-power, quite apart from the fact that the size of the Services themselves inevitably affects the man-power available for civil industry. This may be due to the fact that the Services have been able to recruit only about one-half the graduates they need; but it may be also due to the growing realization that the new defence policy laid down last year, and in particular the concentration on improved weapons, makes a strong research and development effort essential. The Government has come within sight of realizing the fundamental importance of science in the defence effort of Britain and, in particular, of directing the limited resources wisely. It is admitted that there have been signs that the research and development have been overloaded and resources dissipated instead of being concentrated on a limited number of projects of the highest strategic importance. The whole programme is now being thoroughly re-examined in order to ensure a proper balance between the resources available and the projects to which the highest priority should be attached.

It is on the selection of those projects and in its analysis of the strategic factors that the White Paper is weakest and most open to criticism; and strategic weakness could frustrate the purpose of the review of the future development of the Services on which the Government has been engaged. Admittedly, at a time of rapid technical advances, a point will be reached beyond which it is impossible to plan because any conclusions will be based on guesswork. Nevertheless, even when the Government confines its review to probable developments over the next seven years, unsound strategic objectives can defeat the purpose of a review designed to provide the Services with reasonably long-term plans on which their production, training and building programmes can be based, to ensure that the reduction in man-power to about seven hundred thousand proposed by March 1958 is achieved with the least military risk, and that the cost of defence in terms of man-power, materials or money does not overload the economy.

Before considering the strategic aspect, this research and development programme may be examined more closely. The financial provision for research and development in 1956–57 has been increased to provide for new weapons of greater complexity and higher quality; expenditure on production and research is now estimated at £787,580,000 gross, against appropriations-in-aid of American aid receipts amounting to £224,930,000. This figure includes the cost of development work undertaken by industry under contract, and the purchase of stores and equipment for research and development establishments, and is £58,170,000 less than in 1955–56, or 37·5 per cent of the £1,498,700,000 net, compared with 41·5 per cent of the £1,494,200,000 net in 1955–56. The White Paper, in stating that the financial provision for research and development has been increased, gives little idea, however, where the increase has been made; and in the debate in the House of Commons on February 28, Sir Walter Monckton, Minister of Defence, merely gave the total figure as about £200 million. Development of some of the more conventional weapons has been cut out or reduced, though some research and development are continuing on them; but it is clearly the new and technically very complex projects, particularly those associated with the deterrent aspect, which are making increasingly heavy demands on the resources of Great Britain.

The White Paper claims that the whole programme is being kept under review with the dual aims of maintaining the right balance between the newer and the older kinds of development projects, and of ensuring that the effort which is being devoted to defence research and development is deployed to the best advantage. It is also recognized that, within the programme as a whole, the effort on research as distinct from development must be maintained, and that the future effectiveness of the British Armed Forces depends primarily on the wise direction and quality of the research effort. Moreover, apart from the need for maintaining specific research aimed at solving immediate problems, long-term research is of increasing importance as techniques become more complicated.

Admittedly the balance between research and development costs and expenditure on the Armed

* Statement of Defence, 1956. (Cmd. 9691.) Pp. 32. (London: H.M. Stationery Office, 1956.) 1*s.* 3*d.* net.

Forces in general is very delicate; and investment in research and development is bound to be heavy with the rapid advance in science and technology. Nevertheless, the indications of the extent of that effort given in the White Paper do suggest some doubts as to whether, over the past few years, the right projects have been selected and whether that effort is still being too widely diffused. Work on the development of a variety of nuclear weapons, for example, continues to expand, and in relation to home defence the importance of continuing and expanding research into the problems of nuclear warfare, and into the most effective and practical methods of dealing with them, is stressed. Many factors of fundamental importance remain obscure, and the danger of misdirected effort here is admitted. Again, particular emphasis is placed on the development of the ballistic rocket and on the *V* bomber aircraft as a deterrent to aggression. Progress is being made in the development of guided missiles for each of the Services, and increasing effort is being devoted to the solution of the problems of flight at high supersonic speeds, including the problems of take-off from, and landing on, existing airfields and aircraft carriers. Two experimental high-speed submarines should be completed next year, and considerable advances have been made in increasing the range of submarine detection and in associated weapons, while the first guided-weapons trial ship should be in operation next summer.

These are only some of the research and development projects indicated by the White Paper; but they illustrate sufficiently the way in which strategic considerations determine the shape of the research and development effort in Britain. Still more, they indicate the importance of the right selection of objectives; and although reference is made to the continuance of close co-operation with the United States, particularly on guided weapons, they raise also the question whether, in deciding the magnitude and nature of research and development, sufficient regard has been paid not merely to resources but also to the possibilities of co-operation with other countries of the Western alliance. The two main criticisms of the British defence policy and programme are, in fact, whether the thinking about priorities has been sufficiently fundamental and whether, in selecting projects, account has been taken not simply of the right priorities but also of the full possibilities of specialization in arms and functions among the countries of the Western alliance. In particular, may not some of the British research and development projects be wastefully duplicating American work?

Before considering such criticisms, however, it is as well to look at the strategic considerations as presented in the White Paper. First, it is suggested that the primary objective must be to prevent war by the maintenance of the Allied deterrent. We have also to be prepared for the continuance of the 'cold' war—the constant and world-wide threat of Communist penetration short of direct military aggression. Equally, we have to be prepared for the outbreak of localized conflicts on a scale short of world war; nor can the possible use of nuclear weapons in such limited wars be ignored.

Accordingly, the forces required to support present British strategy have a fourfold role to fulfil. They must contribute to the Allied deterrent, commensurate, it is suggested, with Britain's standing as a world power. They must play their part in the 'cold' war. They must be capable of dealing with outbreaks of limited war, should they occur. They must also be capable of playing their part effectively in a world war, should it break out, and this involves full co-operation with the civilian authorities and an organization for home defence which can be readily expanded or adapted as changes in the international situation or the development of new weapons may require.

Sir Walter Monckton, in opening the debate in the House of Commons on February 28, acknowledged the importance of getting the priorities right. The resources available for defence will be stretched to the utmost in meeting even essential needs, and to attempt to do more would impose an intolerable strain on the national economy and thus defeat its own ends. Sir Walter said Britain has never been able to do all that is required for full insurance: something has always had to be left out, and the real question is what is the calculated risk to be taken.

All this was common ground among speakers in the debate. Differences of opinion arose over the nature of the calculated risks, and it is not easy for anyone, denied the full knowledge which the Government alone possesses, to pronounce on the soundness of the particular projects on which the Government has decided to concentrate the limited resources of the nation. Indeed, even with that full knowledge, in an era of rapid technical advance there is, as Sir Walter admitted, an element of guesswork in the Government's own decisions.

In spite of this, however, a certain amount of evidence was advanced during a debate, which generally reached a high level, to suggest that during the past ten years the selection of priorities has not been sound, even when it is remembered that in some fields the choice has not rested entirely with Britain. The debate, however, was valuable not so much for suggesting, subject to the limitation already noted, what the correct priorities might be, as for stressing, first, the need to raise defence above political party issues and to ensure some continuity in the office of Minister of Defence; and, secondly, for indicating some of the factors which should determine the choice of objectives.

One criticism advanced of the Government's defence policy is whether sufficient attention is being given to the possibilities of co-operation or specialization of function with the other countries of the Western alliance. Of this, Sir Walter Monckton observed that there is a continual exchange of information and co-operation in other ways between the United States and Britain, and indeed that there are mutually benefiting arrangements with the United States for the exchange of military information of all sorts, including special arrangements for

collaboration in the vital field of guided missiles. He thinks, however, that in practice there are definite limits to the extent to which the British research and development effort and that of the United States can be made to coalesce. Apart from the dollar difficulty, there are sometimes practical difficulties in making equipment of American design in Britain and incorporating it in British ships, aircraft, etc. British policy, Sir Walter suggested, should be to make the fullest use of the collaboration agreement we have with the United States and other countries to avoid duplication of research and development, but it is also necessary to continue with research and development ourselves over a wide range of projects. Sir Walter admitted that we shall have to be more selective in re-equipping our Forces. Mr. R. R. Stokes's comment here is significant: "We cannot go on behaving in a nuclear age as if nothing much had happened. We need new thinking".

That is particularly true in regard to the policy of graduated deterrence which has been urged on the Government and which was advocated by Prof. P. M. S. Blackett in a lecture at Trinity College, Cambridge, on February 24, when he made some outspoken criticisms of the confusion of thought in planning defence policy. Prof. Blackett said that, while the White Paper contains some sound proposals, it does not reflect the doubts and criticisms which are now being raised, not only as to civil defence but also as to defence policy in general. He thinks that the present confusion arises from the failure of those planning defence to adapt themselves to the change in the comparative strength in nuclear weapons of the East and West since 1950, and urged that some clear definition of the circumstances in which the nations are prepared to use atomic weapons and some definite distinction between their strategic and tactical use are greatly needed.

Sir Walter referred briefly to this matter at the close of his speech, but no more than to indicate that the Government is thinking again as to the possibility of distinguishing between tactical and strategic weapons. Indeed, so far from advocating adoption of a policy of graduated deterrence, he thinks there are solid grounds for believing that, even if the policy is right in itself, it is unlikely to be adopted by other parties to the agreement. Sir Walter leans towards a comprehensive scheme of disarmament, but in doing so he largely shied away from the questions and decisions which should determine the projects on which our resources should be concentrated for effective defence.

Apart, however, from this question of the right choice of projects, there is also the question of the general deployment of scientific and technical resources in Britain. It is admitted in the White Paper, and was recognized in the debates of February 28 and 29, that defence research and development effort make heavy demands on industry in Britain as well as on scientific and technical man-power. The public is not, however, given anything like the information in the White Paper or elsewhere for an outside judgment to be formed as to whether or not that effort is in danger of distorting the national economy or the balance of scientific and technical effort. Concern has sometimes been expressed, for example, as to the effect on the balance of research of the efforts in nuclear physics and the development of nuclear energy, not merely for weapons but equally for peaceful purposes; but there is at present no means of judging how effective a safeguard the organization of defence research in Britain under the Defence Research Policy Committee can provide against such distortion.

It would be reassuring, moreover, if the White Paper had touched on the bearing of technical education in Britain both on recruitment to the Services and on the equipment of the Services to fulfil their function. This, too, is an aspect of the general man-power situation of the country; for defence requirements have to be considered in relation to scientific and technical education, just as they have in relation to scientific and industrial research. Nor will these needs be met effectively except as part of an adequate educational policy for the nation as a whole, which takes full account of particular shortages such as that of science teachers and seeks to meet them by realistic and fundamental measures rather than by expedients which merely create difficulties and undesirable repercussions elsewhere. Any expansion of scientific and technological man-power in Britain, and even in technical man-power, is a long-term process; as Prof. Blackett remarked, defects in an educational system are not quickly repaired, nor is there any easy recovery from false economies in research in the past.

Accordingly, it is important not merely that these resources should be distributed wisely, but also that the best possible use should be made of them where they are deployed, that skilled and highly trained men should not be employed where those less trained would be equally effective, and that neither professional inhibitions nor restrictive practices on the part of employers or trade unions should hinder the development of the nation's full productive capacity. It is these factors which, as much as anything, will determine whether Britain can continue to devote to defence purposes some two-thirds of its expenditure on scientific research (on Mr. John Strachey's estimate); and they give a point to Mr. G. Brown's plea for a further look at the way in which defence research is organized departmentally—the Minister of Supply's assurance that there is little duplication in research was rather bald. There is the additional point that, in the field of defence as elsewhere, the effectiveness of applied research depends on the way it is administered and the degree of understanding of research methods and people, as well as of the problems to be solved, shown by those responsible for that administration. It is always possible to learn from others, and there are more than a few points, for example, in the papers presented last September in the United States at the ninth annual conference on the administration of research at the North Western University Technological Institute, which deserve consideration in this connexion; particularly relevant is Mr. R. A. Morgan's discussion of research relationships between government and

the university, in which defence research was specifically considered.

More even than last year, the latest Statement on Defence puts the whole question of defence and defence research in its proper economic as well as its strategic or political context. The implications are not always pursued or examined and the priorities may be challenged. Though the Government can perhaps be charged with attempting too much and spreading the nation's resources too widely, the first duty of the scientist or technologist is not to attempt to point out what those priorities should be; rather he should stress the relation of the defence effort, and especially that on research and development, to the economic effort generally, and put in perspective the implications of this for the nation's industrial and scientific research effort as a whole, for its technological and scientific man-power and for its educational system.

IMPACT OF SCIENCE ON RELIGION

Modern Science and Christian Beliefs

By Dr. Arthur F. Smethurst. Pp. xx+300. (London: James Nisbet and Co., Ltd., 1955.) 21*s.* net.

DR. A. F. SMETHURST has set before himself an ambitious aim. He surveys the whole range of natural science and considers its bearing on Christian belief with the object of enabling any educated reader to form a reasonable opinion on the subject. He has succeeded in a surprising degree and has written a book which is always lucid and readable; it should help to enlighten many Christians on the present state of scientific thought and perhaps, too, some scientists on modern Christian theology. It is difficult to review such a book, because few could claim so wide a knowledge of the various branches of science, together with the equipment of a theologian, as that possessed by the author—and certainly I am not one of the few.

It is inevitable that not all the sections of the book should be of equal interest, and it will be possible here only to indicate its scope and to direct attention to some controversial points. Dr. Smethurst deals with the inherent limits of scientific knowledge on lines which are familiar, laying stress on the fact that individuality and value seem to be excluded from its investigations. He argues that the Christian belief in God prepared the way for the rise of natural science. In this, he agrees with many other eminent thinkers; but one may, perhaps, hesitate to hold that the belief was an indispensable preparation without which science could not have come into existence. It is always rash to dogmatize on what could or could not have happened, had circumstances been other than they were; and it is enough for Dr. Smethurst's case to state, what is obviously true, that the Christian belief in God was, in fact, one of the conditions in which science came into being. Dr. Smethurst contends forcibly, and surely reasonably enough, that recent advances in physics and astronomy, so far from tending to make theism less easy to accept, have had the opposite effect, and the theistic view finds more support from modern cosmology than it could ever have from the scientific theories of the end of the nineteenth century. When the reader comes to the chapters on biology and psychology he is in the thick of the conflict.

Dr. Smethurst may be congratulated on his firm repudiation of fundamentalism in all its forms and his clear statement of the general evidence for the fact of evolution. He argues that evolution bears the marks of divine purpose and cannot be interpreted adequately unless we see in it the work of creative Spirit. But the problem of evil cannot be ignored, and the author does not evade the issue. In this connexion he has a good word to say for the devil—not, one hastens to add, as a character, but as a hypothesis. His view might be described as a relative and temporary dualism. Support can, of course, be adduced for this conception from the New Testament, and it has *prima facie* an apparent agreement with the facts of experience. Dr. Smethurst is well aware of the philosophical and theological difficulties which would have to be met, but no doubt lack of space prevents him from going deeply into them. No author can be blamed for not producing a final solution of the crux of theism—the problem of evil—but a further development of Dr. Smethurst's thesis would have been welcome.

The chapter on psychology is one of the best in the book, characterized by fair and balanced presentation of the chief theories. Freud's contribution is recognized and duly appraised, while the criticism of his view on the nature of religion is definite and well argued. The value of the book is considerably enhanced by four long appendixes on logical positivism, dialectical materialism, existentialism and the problem of the communication of the Gospel in a scientific age. It is to be hoped that Dr. Smethurst's book will be read by many Christian fundamentalists and by many 'dyed in the wool' agnostics. Both classes of readers will find much to think about.

W. R. Matthews

RADIOACTIVE TRACER TECHNIQUES IN BIOLOGY

Radioisotopes in Biology and Agriculture

Principles and Practice. By C. L. Comar. Pp. xiii+481. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 67*s.* 6*d.*

THE success of radioactive tracer techniques has nowhere been more spectacular than in the biological sciences. The application of radioisotopic techniques to biology and physiology has already resulted in far-reaching advances and continues to develop so rapidly that some knowledge of the possibilities and limitations of tracer methods is now essential to every worker in these sciences. The publication of this informative and factual book, written primarily for the biological student and investigator, is therefore particularly welcome.

The author gives a clear and comprehensive survey of the present situation with regard to radioactive tracer techniques in biology. An excellent balance between principles and practice is maintained throughout, and comprehensive references on all aspects of the subject are quoted. The book will be of particular value to the research worker who wishes to apply tracer methods to his own problem. Its major weakness lies in the omission of an adequate account of the elements of radioactivity physics, and

the newcomer to the subject will need to turn to elementary text-books of physics for a correct understanding of these fundamental principles without which he will not be fully equipped to undertake tracer investigations.

The book opens with an excellent account of the general principles on which different types of tracer studies are based, with examples drawn from a wide variety of biological investigations, and includes a particularly valuable treatment of the kinetics of biological systems as studied by radioisotopic methods. The limitations imposed by chemical effects, radiochemical impurities, radiation effects and isotopic effects are clearly defined. Then follows a practical account of the measures necessary to protect personnel against radiation, including suggested working rules for use in radiochemical laboratories. It is unfortunate that the book was written too early for the inclusion of a summary of the 1955 Recommendations of the International Commission on Radiological Protection, and it is to be hoped that this omission will be made good in future editions.

A useful chapter outlines plans for typical laboratories for radioactive work and gives much practical information regarding methods of administration of active materials to both animals and plants and methods of sample collection. The section devoted to techniques for the radioactive assay of biological samples is less successful owing to the inadequacy of the physical treatment. While the author cannot be criticized for not giving a detailed discussion of the scalers and other electronic equipment used in assay work, the omission of a satisfactory description of the fundamental properties of the Geiger–Müller counter, scintillation counter and ionization chamber and of the mechanism of radioactive decay is difficult to justify.

A detailed summary of the properties of selected radioisotopes is given, with examples of investigations illustrating the procedures, equipment and precautions necessary for their use. The data presented for each isotope include the specific activity available, the minimum detectable activity using different assay methods, and figures relating to radiation protection. While they form a useful guide, these data should be accepted with some reserve in view of the present rapid improvement in technique. The specific activities listed are those obtainable from the Oak Ridge reactor in the United States, and do not necessarily apply to preparations obtained from other sources. It may also be noted that the protection data are in some cases at variance with the latest Recommendations of the International Commission on Radiological Protection. A select bibliography accompanies the information relating to each isotope.

The final chapters discuss the allied techniques of autoradiography, paper chromatography, ion exchange and activation analysis which play so important a part in tracer studies. These chapters are all excellent. Their scope is much wider than the limited field of radioactive tracer methods, and they give a clear and concise introduction to these fascinating techniques.

The general format and production maintain the high standard expected from the publishers. This book, while not to be regarded as a standard work of reference, will form a valuable addition to the library of the biological research worker.

E. H. Belcher

HANDBOOK OF ORGANIC COMPOUNDS

Organic Solvents

Physical Properties and Methods of Purification. On the basis of the First Edition by Arnold Weissberger and Eric S. Proskauer. Completely revised Second Edition by John A. Riddick and Emory E. Toops, Jr. (Technique of Organic Chemistry—Vol. 7. Edited by Arnold Weissberger.) Pp. vii + 552. (New York: Interscience Publishers, Inc.; London: Interscience Books, Ltd., 1955.) 8.50 dollars.

THE statement on the dust cover claims that this volume provides "a guide and reference book for everyone engaged in synthetic organic work, in the study of reaction mechanisms, and in the study of non-aqueous solutions and titrations". This provides a better description of the contents of the book than the main title, since the volume does not, in fact, record the solvent properties of any compound.

The physical properties and numerical values tabulated can be grouped into four main types: values useful for the identification of pure substances and as criteria of purity (for example, boiling points, melting points, etc.); values useful in connexion with physico-chemical measurements (for example, ebullioscopic constants, etc.); properties useful for the study of solute systems (for example, electrical conductivities, spectra, etc.; no spectra are shown, however, but references are given to sources); and properties important for the handling and storing of solvents (for example, flash points and toxicities). The various constants are listed under the names of the compounds; but there are also tables of boiling points, freezing points, dielectric constants and dipole moments with the properties arranged in order of increasing magnitude. A chapter is devoted to a discussion of criteria of purity, drying techniques and determination of water. A large section consisting of 163 pages which describes various purification procedures for each compound is followed by a bibliography, a list of 2,169 references to the literature and an index.

The occurrence of *cis*- and *trans*-isomers of certain cyclic compounds has given the compilers of this volume a great deal of trouble. Thus, although it is stated on p. 314 that "Decahydronaphthalene from different sources will show considerable variation in composition of the *cis*- and *trans*-isomers", the results of very precise measurements made on unspecified mixtures of isomers are presented on p. 68. Similarly, the properties of 2-, 3- and 4-methylcyclohexanol are tabulated, although there is no indication whether the values quoted refer to the *cis*- or *trans*-isomers or to a mixture of these materials.

The molecular weights given are not now correct to the number of figures quoted, because the 1953 International Atomic Weights were not employed. Thus, the molecular weight of cyclopentane should be 70·135 and not 70·130 as printed. Some of the constants appear to have been recorded with a much greater precision than the experimental results warrant. For example, several flash-points are given to the nearest 0·1 deg. F., whereas this constant is rarely known to within 5 or 10 deg. F. Thus, the flash-point of *n*-heptane is quoted as 20·6° F., whereas values ranging from 25 to 63° F. are given in the pamphlet "Fire-Hazard Properties of certain Flammable Liquids, Gases and Volatile Solids"

(National Fire Protection Association, Boston, 1946), which recommends 25° F. as the selected value. Errors in the structural formula of the following compounds were noted (page numbers in brackets): 3-methylpentane (55); 2,2-dimethylbutane (56); 2,2,3-trimethylpentane (65); *p*-xylene (76); 2-pentanol (99); 3-methyl-1-butanol (101); methylal (130); 4-methyl-2-pentanone (141); *o*-fluorotoluene (181); *m*-fluorotoluene (182); *p*-fluorotoluene (182); pyridine (243); and thiophene (248). The molecular formula for oleic acid (p. 151) is also incorrect.

The difficulties in producing a book of this type are considerable, but this compilation is so useful that it is to be hoped that a further twenty years will not be allowed to elapse before the appearance of the third edition.

CRYSTALLIZATION OF HIGH POLYMERS

Some Aspects of the Crystallization of High Polymers

By G. Schuur. (Communication No. 276.) Pp. 82. (Delft: Rubber-Stichting, 1955.) 5 Dutch florins.

THIS is a small monograph dealing with a topic which is of considerable current interest. The mechanism of crystallization of an amorphous solid to a crystalline substance is not easy to elucidate. When a polymer is being dealt with, the difficulties increase immensely, and mobility is restricted in a way that does not occur with simpler systems. The trouble here is to try to deduce something about the mechanism and structure of the crystallites formed during the process by observations on the rate of formation of the nuclei, the rate of growth of the crystallites, and the optical properties of the crystallites. Thus, there is a limited amount of experimental data that can be obtained in such systems, and the interpretation, therefore, is still open to considerable discussion.

The author is a member of the Rubber-Stichting in Delft, and naturally he has a considerable interest in the crystallization phenomena exhibited by rubber. In addition, however, he discusses work done on polyamides and superesters, which are equally relevant to this topic.

The book is divided into a number of chapters which introduce the subject to anyone who is not particularly familiar with it. First there are general remarks about crystallization and the problem of liquid crystals. Next is a factual description of what has been observed about spherulitic formation in solid high polymers, and then follow three chapters on the more controversial aspects of methods of crystallization, the rate of crystallization, and phenomena of melting in high polymers.

The book is lavishly illustrated with extremely good photographs of typical spherulites and their behaviour in a number of systems, which convey in a much better form than any tabular data the qualitative nature of these phenomena. The book will provide much stimulus to those engaged in similar work and should also be an extremely useful guide to those who want to know in a general sort of way what is happening in this field of polymer chemistry.

H. W. Melville

MICROSCOPY OF CERAMICS AND CEMENTS

Microscopy of Ceramics and Cements, including Glasses, Slags, and Foundry Sands

By Herbert Insley and Prof. Van Derck Fréchette. Pp. xii+286. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 7.50 dollars.

THE use of the polarizing microscope for the study of ceramics and cements has developed considerably in recent years, and a book such as this is welcome. For each group of ceramics, and for refractories and cements, the authors give brief accounts of the raw materials employed and of the behaviour of ceramic materials during firing operations and of cement during hydration. There are short introductory chapters on the microscope and on optical mineralogy, but the authors very rightly refer their readers to standard text-books for further details and also for tabulated and classified data of the optical characters of the minerals and artificial crystalline materials concerned. The characters of the minerals used as raw materials are, however, given in a separate chapter and their thermal behaviour is outlined. Obvious characters by which the materials produced in firing processes may be recognized are described as the occasion arises. The photomicrographs illustrating these descriptions are excellent.

There are two chapters on the preparation of materials for the microscopic examination and on special techniques and, apart from these, there are separate descriptions of methods used for especially difficult materials such as cement clinker, hydrated cements and porcelain enamels on metal. A very high standard of section-cutting must be attained, sections of cement clinker being worked to less than half the thickness of 30μ used for rock sections. Methods of impregnating friable materials and the use of synthetic thermoplastic cements in place of the old-established Canada balsam are described in detail. For the study of some materials too dense to give good results with transmitted light, polished thin sections are prepared and are viewed by reflected or oblique illumination. These are particularly useful for cement clinker, aluminous cements and basic refractories. Delicate etching with very dilute reagents enables the different components to be recognized.

The chapter on glass describes crystalline solids likely to be encountered as 'stones' in the glass. These may be derived from the batch itself, from the refractories in the walls of the pot, or by devitrification. A binocular microscope with oblique illumination can advantageously be used in this work on glasses, and another device, used in the examination of porcelain enamels on metal surfaces, illuminates the specimen through one eyepiece of a binocular, the observer looking through the other.

A criticism may be made that the authors have attempted too much in a small compass; but they have succeeded in giving an up-to-date summary, for each branch of ceramics and cements, and have supplemented every chapter with a fairly full list of references to modern literature on the subject which will direct workers in Britain to most of the recent American work in these fields.

W. Campbell Smith

Lehrbuch der anorganischen Chemie

Begründet von A. F. Holleman. (34–36, wesentlich umgearbeiterte und erweiterte Auflage.) Bearbeitet von Prof. Egon Wiberg. Pp. xxviii+661. (Berlin: Walter de Gruyter and Company, 1955.) 28 D. marks.

TRANSLATIONS of the late Prof. A. F. Holleman's books on inorganic and organic chemistry have instructed generations of students. They were characterized by clarity and a wise selection of fundamental material. Although as Prof. Egon Wiberg says, his revision bears little relation to the original "Holleman", it preserves the good points of its ancestor.

The text is thoroughly modern, the electronic theory of valency being amply used in it, and the old formulations of inorganic compounds have been replaced by present-day ones. Physico-chemical principles, such as the phase rule and the theory of equilibrium, are freely used. The newer aspects of the subject come at the right places in the text, and difficult topics are dealt with in stages. The theoretical parts of the book are modern and correct. The treatment of the individual elements and compounds is concise yet thorough, and includes more advanced topics of considerable interest, such as the structure of the silicates, the metal carbonyls and the hydrides of boron. The rarer elements find a satisfactory place, and there are brief but good descriptions of industrial processes. There are many tables of physical properties and an excellent index, so that the book is very convenient for reference.

The text is divided into short sections with clear headings, which will facilitate study, and the treatment of each element follows a regular order of occurrence, preparation, physical properties, chemical properties and uses. The nomenclature is based on Stock's scheme, which is becoming more used in all quarters. The illustrations are mostly curves, diagrams of structure and technical apparatus, ordinary preparative laboratory apparatus, even of a specialized type, not finding a place. This book is clear, systematic, sufficiently detailed, and highly informative. It can be warmly recommended.

British Wild Flowers

By Dr. John Hutchinson. Vol. 1: Pp. 492. Vol. 2: Pp. 493–947. (Pelican Books Nos. *A*.330 and 331.) (Harmondsworth, Mddx.: Penguin Books, Ltd., 1955.) 5*s*. each volume.

DURING the past few years Dr. John Hutchinson has been occupied in a revision of Bentham and Hooker's monumental "Genera Plantarum", but this enormous task has not prevented him from writing a number of volumes dealing popularly with the British flora. His first three works in the Pelican series were written expressly for those with no knowledge of botany but who wanted to learn the names of the wild plants of the countryside. Undoubtedly these convenient manuals provided a simple and easy introduction to the study of our native plants. They had no systematic arrangement, though plants belonging to the same family were kept together. The latest volumes, which include the contents of the three earlier books with some additional species, correct this unsatisfactory situation, and the sequence of the species described and figured follows the author's system of classification.

The work certainly gives a good general survey of the British flora, though the inclusion of so many adventive species is perhaps unfortunate as there are significant omissions among the native plants and some indigenous genera get rather scant treatment. This is certainly so in the case of aquatic plants. The genus *Callitriche* is entirely omitted, and other groups are poorly represented. Under *Utricularia* it would have been better to refer to the work of Lloyd, who showed convincingly that the bladders were not the static organs they were supposed to be, but ingenious traps which could be set at tension ready to be sprung by contact on sensitive hairs.

The two volumes, in conjunction with C. E. Hubbard's "Grasses" in the same series, can be recommended to amateur field-naturalists needing an authoritative and inexpensive guide to wild flowers in Britain.

Further Outlook

By F. H. Ludlam and R. S. Scorer. Pp. 174+13 plates. (London: Allan Wingate (Publishers), Ltd., 1954.) 15*s*. net.

IT is the avowed aim of the authors of this interesting and unusual book "not to write a text on the science of meteorology . . . but rather to explain a philosophy of the science of weather study which will enable us to understand its probable future achievements". The result of this laudable purpose is that the essence of the contents is likely to be fully savoured only by the meteorologist, who will be delighted by the novel treatment of certain parts of his subject but occasionally surprised by quite reckless pronouncements. Surely few forecasters would agree with the authors that the geostrophic wind equation is "the only theoretical result which is constantly put to practical use", or that "no great forecaster has ever written a tract that has found a place amongst the teaching texts of meteorology".

The authors are distinguished for their work in cloud physics and on mountain waves, respectively, and the chapters headed "Exploiting the Atmosphere" and "Weather Control" are those most likely to interest the general reader. The first of these deals with the development of thermals and wave clouds and with the techniques of soaring flight; there is an intriguing analysis of the dynamic soaring of the albatross. The other is concerned with ways in which weather may be artificially modified, in particular with the physical processes involved in cloud seeding and with the difficulties of assessing whether or not rain-making experiments are effective. The book is illustrated by very fine cloud photographs.

JAMES PATON

Dancers of God

By Nöel Ballif. (Translated from the French by James Cameron.) Pp. 213+32 plates. (London: Sidgwick and Jackson, Ltd., 1955.) 15*s*. net.

THE author, M. Nöel Ballif, in company with a team of anthropologists and cinema technicians, and with the backing of the Musée de l'Homme, organized an expedition into the forest country of the French Congo to study the pygmies of the region and to make film and sound recordings of their way of life. The book is essentially a travelogue, delightfully written and well translated, and with an interesting account of the daily life of the pygmies with whom they were lucky enough to make friendly contact.

This is in no sense a serious anthropological work, but the description is useful in the same way as are the descriptions of remote peoples by the early

voyagers; they give the layman a more vivid picture than a whole book of expert knowledge. An account of hunting with nets and spears is excellent. The book ends with a brief chapter—one might almost call it an appendix—summarizing in five pages the physical anthropology of African pygmy peoples, by Raoul Hartweg, and a list of the anthropological results of the expedition. The book serves to whet our appetite for the more serious and scientific work which will no doubt follow in due course.

Atom Harvest

By Leonard Bertin. Pp. 253+23 photographs. (London: Martin Secker and Warburg, Ltd., 1955.) 20*s*. net.

THIS is a remarkably fine account of a complicated field in which the reader is not asked to worry over-much about scientific or engineering detail at any stage, but nevertheless acquires an accurate broad understanding of the principles involved. Mr. L. Bertin is to be congratulated on accomplishing very adequately on the British side what Mr. Gordon Dean achieved in respect of efforts in the nuclear field in the United States. He considers at some length the history of the thorny questions of collaboration between the two countries, and many readers will be grateful for his forthright way of tackling the subject.

To the general reader interested in a field of paramount importance to the future of the United Kingdom and the Commonwealth, this is a book which can be highly commended. Even the specialist must find within its pages much to interest him, since few can be familiar with all the many facets of the vast programme set forth in it.

In one respect the reviewer found the book fell short of expectation. More consideration should have been given to the present trends in tracer research, and its rich promise for the future of scientific effort in Britain might have been more thoroughly examined. This need not have meant a longer book as the space could have been saved elsewhere without appreciable loss to the reader; for example, the profusion of discussions set forth could have been pruned severely. S. C. Curran

Metals Reference Book

By Dr. Colin J. Smithells. Second edition. Vol. 1: Pp. xvi+532+17. Vol. 2: Pp. xv+533–967+17. (London: Butterworths Scientific Publications; New York: Interscience Publishers, Inc., 1955.) £8 8*s*. net the set.

NO one can deny the usefulness of this book, nor the attractiveness of the volumes, although the cost is almost prohibitive for the individual. The aim has been to supply a collection of data relating to metallurgy and metal physics, and to a large extent this has been done in tabular or diagrammatic form.

The scope is wide, in fact so wide in some respects that it encourages an impression that there are omissions. A large part of the subject-matter is fundamental data, such as mathematical formulæ, conversion factors, constants, thermo-chemical data, atomic characteristics, equilibrium diagrams, on crystallography and a considerable range of important physical properties, together with sections on metallography and mechanical properties. On the practical side, the topics include: fuels and refractories, foundry details, lubricants, corrosion, electroplating, and welding. It is the catholic nature of the selection on these aspects that prompts the feeling that comparable subjects have been omitted.

The second edition has involved considerable revision of data, the rewriting of some sections, the addition of more material, and a more elaborate bibliography; resulting in its presentation in two volumes. A commendable point in this connexion is that both volumes contain the index. In all, this can be regarded as an essential reference book for metallurgists and others working with metals.

A. R. Bailey

A History of the Classification of the Phylum Brachiopoda

By Helen Marguerite Muir-Wood. Pp. vii+124. (London: British Museum (Natural History), 1955.) 20*s*.

THE Brachiopoda are an interesting group with a long fossil history, but their position in relation to other groups is not satisfactorily determined. In the past they have been associated with a number of the major phyla of the invertebrates. Perhaps the smaller group with which they have been linked most frequently is the Bryozoa, but the consensus of opinion now is to regard these as two separate phyla; indeed, some authorities suggest that the Brachiopoda should be subdivided into two phyla, but in this present work Dr. H. M. Wood prefers to regard the Inarticulata and the Articulata as classes. She has gone into the history of all these changes, starting with the first illustration of a member of the group by Conrad Gesner in 1565 but paying particular attention to them since 1785, the crucial date from the point of view of nomenclature.

This useful work is not intended as a definitive classification, but it is a fully documented presentation of the past and present position with regard to their classification. Subsequent workers will be grateful to Dr. Wood for this essential clearance that will enable detailed revision to be started so much more easily. In this, the relevant bibliography, carefully checked, and the full index will be most useful.

British Trade Unionism

Five Studies by P.E.P. New and revised edition. Pp. xi+199. (London: P.E.P. (Political and Economic Planning), 1955.) 16*s*.

THIS new and revised edition appears in a new format, with five studies only, instead of the previous six. Though the framework has been retained and many passages are virtually unchanged, much of the book has been rewritten, and the first study, in particular, with its statistical analysis of the number, size and type of unions in Britain, has been brought up to date. While the book remains a most useful factual handbook, by omitting the sixth study, that of the implications for the trade unions of the changes in post-war Britain, it appears to have lost much of the value which the earlier edition possessed as a stimulus to the fresh thinking about the functions and organization of the trade unions under conditions of full employment. Such issues as the 'closed shop', the unofficial strike, the problems presented by the nationalized industries and the appropriateness of trade-union organization to present-day conditions and their implications, are not brought out in this new edition, which lacks accordingly much of the challenge which the former edition offered.

ROCKET EXPLORATION OF THE UPPER ATMOSPHERE

By Dr. F. E. JONES
Royal Aircraft Establishment, Farnborough
AND
Prof. H. S. W. MASSEY, F.R.S.
University College, London

At a meeting of the Gassiot Committee of the Royal Society (of which one of us (H. S. W. M.) is chairman and the other a member) held on October 20, 1953, the possible British participation in a programme of observation of conditions in the upper atmosphere by means of rockets was considered. It was concluded that a British programme would be worth while and possible if support were forthcoming from the Ministry of Supply, and in particular the Royal Aircraft Establishment, which would be required to design a suitable rocket and provide firing facilities.

Details of a possible collaboration between the Gassiot Committee and the Royal Aircraft Establishment were discussed at Farnborough on January 29, 1954, and, as a result, the agreement in principle of the then Minister of Supply, Mr. Duncan Sandys, was obtained in March 1954. The final recommendations of the Gassiot Committee were endorsed by the Council of the Royal Society in November 1954, and the participation of the Royal Aircraft Establishment in the experiment was put on a firm footing as a result of the exchange of letters between Sir David Brunt, secretary of the Royal Society, and Sir Owen Wansbrough-Jones, chief scientist, Ministry of Supply, during the period November 1954–February 1955. Treasury support to the extent of £100,000 spread over four years was agreed on June 29, 1955, to be divided into £50,000 to cover the design and provision of rocket vehicles by the Royal Aircraft Establishment and £50,000 to be made available to the Gassiot Committee, through the normal Air Ministry channel, to cover the cost of the experimental investigations. Some details of the arrangements were released to the popular press in August last. The present article gives details of the rocket, now known as the 'Gassiot vehicle', and an outline of the initial experiments to be undertaken with it.

In designing the rocket vehicle, the considerations of ease of manufacture, preparation for firing and total cost per flight have been kept very much in mind. From these considerations the design has been centred on a single-stage uncontrolled rocket propelled by a solid-fuel motor, the problem being to achieve great height at reasonable cost. The advantages of releasing the rocket from a balloon, in a similar manner to the American 'Rockoon', have been considered; but it was concluded that by suitable choice of motor burning-time the loss in performance due to aerodynamic drag in the lower atmosphere could be considerably reduced and the additional expense and complication of a balloon launch avoided. In addition, a delay of half an hour or more required for a balloon to reach altitude before firing the rocket would not be acceptable in some experiments.

Much in the way of final performance of the rocket depends on the burning-time of the motor. A fast-burning motor produces high velocities in the lower atmosphere with resultant excessive drag. A slow-burning motor usually means a reduction of specific impulse and, because of the lower accelerations involved, the dispersion problems in an uncontrolled vehicle increase. The optimum burning-time seems to lie in the region of 30 sec. and this is the value chosen for the Gassiot vehicle.

The outline design of the rocket is shown in Fig. 1. The fins are of an existing design and later versions will not have swept trailing edges. The nose cone, which will house the instrumentation, is made of 14-gauge steel with provision for jettisoning the forward portion at the 10-in. diameter region. Just aft of the nose cone is a portion of the body which houses the telemetry, ancillary instrumentation and power supplies. The total weight of the rocket at launch will be just over 2,500 lb., by far the greater portion of which is fuel. The total payload made up of instrumentation and telemetry equipment for a height of 550,000 ft. is 150 lb.

The launcher is illustrated in Fig. 2. The structure consists of a vertical 'boom'—the launch way—supported at approximately its mid-point in a gymbal system, the gymbal framework forming the apex of a large tripod. The launching angle is variable through $\pm 10°$ in azimuth and from 75° to 95° in

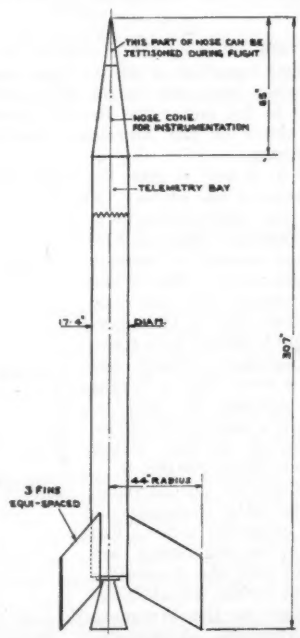


Fig. 1. Gassiot rocket vehicle

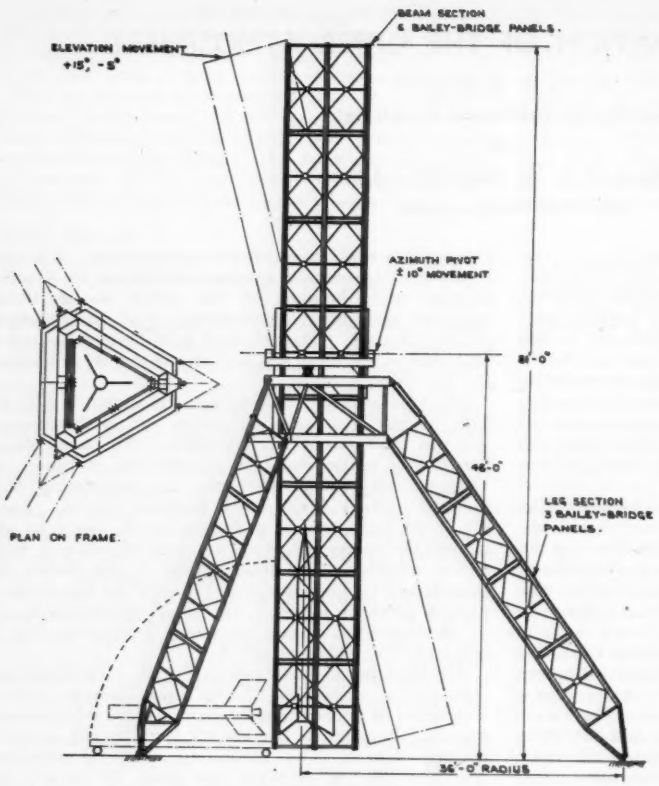


Fig. 2. Launcher. Approximate weight of structure is 35 tons; the three legs equally spaced

elevation, thus allowing for a variety of wind conditions. The launcher is 81 ft. high, stands on a 72-ft. diameter base and weighs about 35 tons. It is designed to fire either the British Gassiot vehicle described above or the American 'Aerobee' rocket without change.

Figs. 3, 4, 5 and 6 give the main performance characteristics of the rocket. Fig. 3 gives the velocity–time and height–time performance curves; Fig. 4 the height–range curves for various launch trajectories; Fig. 5 the acceleration–time curve for vertical flight and Fig. 6 the maximum height reached as a function of payload. From the curves it is seen that a height of about 550,000 ft. will be reached with a payload of 150 lb. Later versions of the rocket should reach about 700,000 ft.

The vehicle is uncontrolled, and consequently dispersion is largely an unknown factor. For this reason arrangements are being made with the Australian Government for the initial firings to take place at the Woomera Range in Australia. A launcher is due to be shipped there this spring to enable experimental firings to be done in the September–October period of 1956. It is hoped to undertake firings both at Woomera and in the United Kingdom during the International Geophysical Year (1957–58). If these tests show that the dispersion is excessive, a boost to increase the velocity at launch or a small rocket motor to produce rolling for the first 5 sec. of flight will be introduced.

The actual upper-atmosphere experiments are being designed and the flight instrumentation made by a number of university departments and by the Royal Aircraft Establishment under the general guidance of the Gassiot Committee. University College, London (Prof. H. S. W. Massey, Dr. R. L. F. Boyd), are to measure wind, temperature and pressure by the grenade method. In this experiment observations are made at a number of points on the ground of a series of grenades fired from the rocket at approximately equal intervals along the trajectory. In addition, University College, London, also plans to fly a mass spectrometer for ion sampling. The University of Birmingham (Prof. J. Sayers) is to make a study of ionospheric conductivity and relative concentration of electrons to negative ions by a sampling ionization chamber fitted with a pulse method of distinguishing between ions and electrons. The Queen's University of Belfast (Prof. D. R. Bates) is to make measurements with photoelectric photometers and filters to study the relative intensities of certain spectral lines of molecular oxygen and the altitude of the night airglow in the regions of the oxygen green line and the Meinel OH bands; it is also planned to study the emissions resulting from the

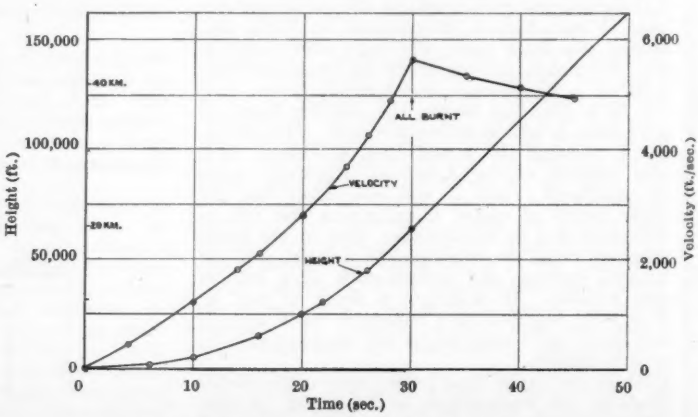


Fig. 3. Velocity–time and height–time performance curves

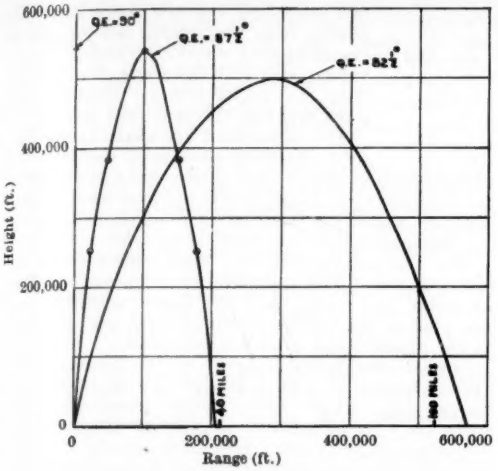


Fig. 4. Height–range curves

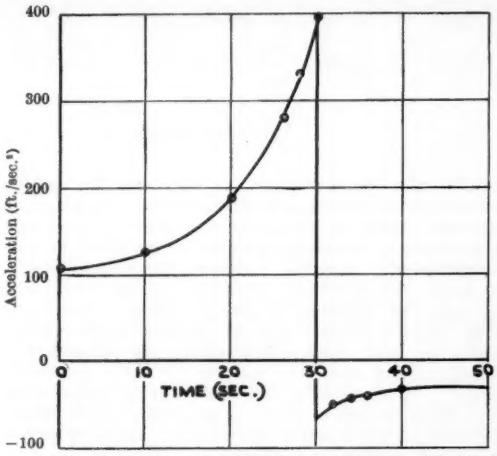


Fig. 5. Acceleration–time curve for vertical flight. The final deceleration is 1*g*

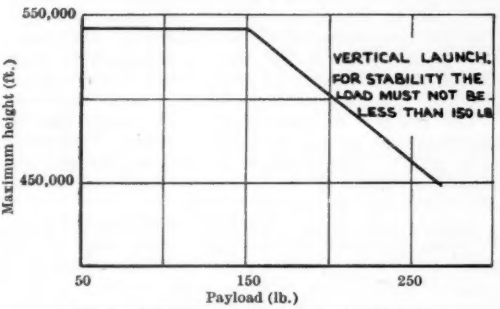


Fig. 6. Maximum height as a function of payload

release of sodium and potassium vapour at high altitudes. University College, Swansea (Dr. W. J. G. Beynon), is working on two methods—continuous-wave Doppler and the pulse method—of measuring electron densities in the ionosphere and is correlating these simultaneously with measurements made from the ground. The Royal Aircraft Establishment is planning to measure skin temperature and altitude of the rocket and is also studying the design of a sun-seeker for carriage in the rocket. The sun-seeker would be used for measurements of solar radiations and for obtaining ultra-violet pictures of the sun at high altitude.

The rate of progress in the design and construction of the various instruments is such that there is every likelihood of a number of measurements being made during the International Geophysical Year.

Acknowledgment is made to the Controller of H.M. Stationery Office for permission to publish the illustrations.

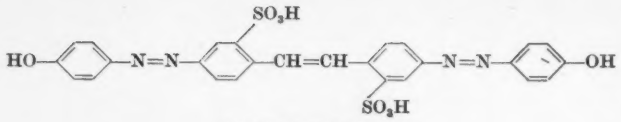
RECENT ADVANCES IN THE CHEMISTRY OF COLOURING MATTERS

ON February 2, the Chemical Society held a symposium in London on "Recent Advances in the Chemistry of Colouring Matters". This was organized by Prof. E. A. Braude (Imperial College of Science and Technology, London) and held in the Royal Institution. Prof. W. Wardlaw, president of the Society, opened the proceedings. He reminded those present that this year marks the centenary of the discovery by W. H. Perkin of the very first synthetic dyestuff, mauve. He quoted Sir Robert Robinson to the effect that the discovery itself had little scientific importance: what was important was the fact that Perkin embarked upon its manufacture, which he achieved, and he thus became founder of the coal-tar dyestuffs industry.

Dr. R. P. Linstead (vice-president of the Society) took the chair for the afternoon session. The following papers were read: "Steric Effects in Azo and Indigoid Dyes", by W. R. Brode (U.S. Bureau of Standards, Washington); "*Cis-trans* Isomerism in Azo-dyestuffs", by R. H. Peters and E. Atherton (Manchester College of Technology); and "Synthesis of Azaporphins and Related Macrocycles", by J. A. Elvidge (Imperial College).

Dr. Brode gave evidence that there is no selective adsorption of certain optically active dyes on asymmetric fibres such as wool, silk or cotton. However, with simpler compounds, for example, *m*-nitromandelic acid, there is selective adsorption of one of the optical forms. It appears that the resonance centre of the dye molecule is more important for adsorption than an asymmetric centre, particularly in the absence of conjugative coupling between the two.

Dr. Brode then described *cis-trans*-isomerization effects in dyestuffs. Changes in light absorption on irradiation can be correlated with *trans* to *cis* isomerization about azo-links. *Ortho* substituents



(I) Chrysophenine *G*

inhibit this phototropism, as also can hydroxylic solvents by a hydrogen-bonding effect. Studies have also been made on bis-azo dyes in order to determine the extent of resonance interaction between the two chromophoric centres. Where the chromophoric systems are insulated sterically or by methylene groups, the property of direct dyeing of cotton is lost. For dyes of this class which show phototropism, only *cis*- and *trans*-modifications are apparent in solution and the spectral curves show isosbestic points. When there is conjugative coupling between the chromophoric systems, an isosbestic line is found, because of the possible existence of an intermediate *cis-trans*-chromophoric system.

The bis-azo stilbene dye, chrysophenine *G* (I), shows phototropism in aqueous solution, but this is restricted to intensity, rather than colour, changes. The two azo-benzenoid chromophores are electronically connected and the dye is substantive, even though the sulphonic acid groups *ortho* to the stilbene ethylenic linkage prevent coplanarity in the molecule.

The absence of phototropism in indigo can be attributed to strong hydrogen-bonding. There is none in NN′-diacetylindigo or -dimethylindigo, and these derivatives show phototropic inversion, as also does thioindigo in neutral solution.

Lastly, Dr. Brode described association effects. Whereas mixtures of brilliant yellow and guinea green show summation spectra, brilliant yellow and genacryl pink do not because of association. Optical bleaching agents, which in effect are colourless dyes, may also associate with dyestuffs and thereby affect their colour. The prevention of association by heat, powerful solvents and dispersoids has been studied, particularly for the system chrysophenine *G*–sky blue *FF*. Here, irradiation also causes a change toward the summation spectrum, apparently because of inversion of chrysophenine *G* into its *cis*-form, which does not associate with sky blue *FF*. The association of dyes appears to be an adhesion of strongly charged resonance structures, probably closely akin to the adhesion to fibres, which are isoelectric charged materials. In each case, the distortion of the resonance system, consequent upon the adsorption, could account for the slight change in absorption spectrum.

The second paper, read by Prof. Peters, provided evidence that *trans* to *cis* isomerization in azo-dyestuffs is responsible for the fading or change in colour of dyed textiles in light: the *cis*-form would be removed in subsequent washing of the textile, as it is not firmly adsorbed in the fibre. In fading experiments, the rates of destruction of a series of benzene-azo-α-naphthylamines, substituted in the benzene nucleus, were determined. Rate constants for the *cis* to *trans* change of these compounds in the dark were also measured, and the activation energies found to be around 20 Cal. This supports the assumption that the phototropy is the result of inversion of the azodye to the *cis*-form in light.

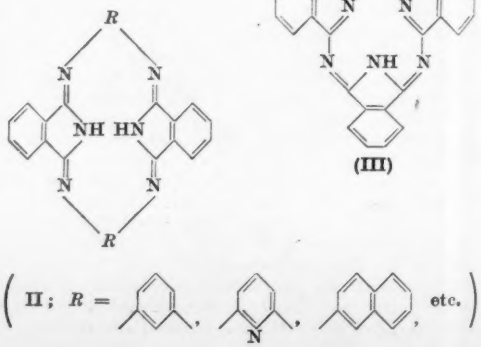
The phototropy of the direct cotton dye, chrysophenine *G*, was also studied. There are three possible centres about which *cis-trans* isomerism can occur, but since the spectra show isosbestic points, only two forms are present in the irradiated solutions. Rates of conversion and activation energies indicate that the transformation involves azo links and not the ethylenic group.

The absorption spectrum of the *cis*-form was determined from the spectrum of a mixture of the two forms by a method involving the dependence of the optical density on wave-length. Also the *trans*-form could be removed from a mixture by chromatography on cellulose powder.

The *cis*-form showed very little substantivity for cellulose fibre. This suggested that the dye needs to be linear and planar, and the latter condition does not hold in the *cis*-form. No *cis*-form was detected in the spectrum of dyed cellulose sheet.

Similar considerations apply to the interaction of chrysophenine *G* with chlorazol sky blue *FF* (Col. Index, 518), which has a linear structure. The spectrum of a solution of a mixture of these dyes departs from additivity. Irradiation causes a change towards the summation spectrum, because doubtless the non-linear and non-planar *cis*-form of chrysophenine *G* is unable to adlineate itself alongside the linear and planar molecule of sky blue. In the dark, the system recovers its original absorption spectrum at a rate equal to the *cis* to *trans* conversion for chrysophenine *G*.

The third paper, on the synthesis of azaporphins and related macrocycles, was given by Dr. Elvidge. The established methods for synthesis of the phthalocyanines have, of course, been extended to the preparation of symmetrically substituted tetrazaporphins, but they are unsuitable for the preparation of unsymmetrical derivatives. In 1950, Prof. R. P. Linstead had suggested the use of imidines as intermediates. The imidines (nitrogen analogues of cyclic anhydrides) are readily obtained from vicinal dinitriles and ammonia. One of their many reactions is ready condensation with amines, and this led to unexpectedly easy syntheses, from phthalic imidine and cyclic-1 : 3-diamines, of cross-conjugated macrocycles (II) with 16-, 20- and 24-atom rings. These compounds are mainly yellow. That with *R* = 2 : 6-pyridyl has a central arrangement akin to that in the azaporphins and, like them, complexes bivalent tetra-co-ordinate metals.



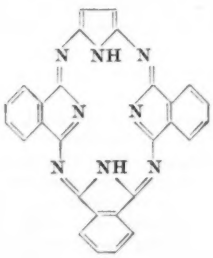
(III)

(II; *R* = , , , etc.)

Resulting from an attempt to separate the several stages which must be involved in the formation of the macrocycles (II), the red, cross-conjugated macrocycle (III) was obtained. This has, in a sense, three-quarters of the chromophore of phthalocyanine.

Dr. Elvidge then outlined working principles which seem to apply to the *self*-condensation of imidines. A mixture of three molecular proportions of an unsaturated imidine with one of a saturated imidine can give rise directly, by elimination of four molecules of ammonia, to a tetrazaporphin; other proportions, and self-condensations, can yield tetrazaporphins only through supplementary oxidation-reduction processes and are in general unfavourable.

Interaction of the imidines derived from phthalonitrile and succinonitrile affords tribenzotetrazaporphin (IV), the first unsymmetrically substituted tetrazaporphin to be isolated and fully characterized. This and homologues are of interest for their light absorptions and behaviour on hydrogenation. The tribenzotetrazaporphins can yield comparatively stable dihydro derivatives, like the porphyrins, in contrast to the symmetrically substituted azaporphins, the reduction of which has so far resulted in the isolation only of tetrahydro derivatives.



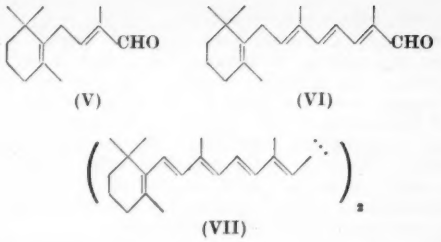
(IV)

By the condensation of a mixture of appropriately substituted imidines, an alkyl substituted tetrazaporphin had been prepared which is at the tetrahydro level: this can only pass to the normal tetrazaporphin 'aromatic' level by the migration of alkyl groups, so that it is ordinarily stable and easy to handle. It was hoped through this and related macrocycles to determine the relative positions of the hydrogen atoms in the tetrahydroazaporphins and thence in those hydroporphyrins which are at the bacteriochlorophyll level.

The afternoon session of the symposium concluded by an open discussion, which lasted some forty-five minutes. One participant, Dr. J. S. Holt (Courtauld Institute of Biochemistry), presented strong evidence for intermolecular, as opposed to intramolecular, hydrogen bonding in indigo.

At 7.30 p.m. Sir Alexander Todd took the chair for the evening session. The papers read were: "Synthetic Carotenoids", by O. Isler, H. Lindlar, M. Montavon, R. Ruegg, G. Saucy and P. Zeller (F. Hoffmann–La Roche and Co., Ltd., Basle), and "Modern Theories of Colour", by M. J. S. Dewar (Queen Mary College, London).

Dr. Isler indicated some carotenoids that his group has synthesized: β-carotene, 7 : 7′-dihydro-β-carotene, lycopene, zeaxanthin, cryptoxanthin, physalien and bixin, and the building principles employed in the manufacturing processes.



(V) (VI)

(VII)

β-Carotene is being produced—in ton quantities—starting from β-ionone. This is converted to the C_{14} aldehyde (V) by glycidic ester synthesis and treatment with alkali. The carbon chain is then lengthened by the reaction of the acetal of (V) with ethyl vinyl ether. Treatment of the product with acetic acid gives the crystalline C_{16} aldehyde, which is then converted to the C_{19} aldehyde (VI) by similar steps involving ethyl propenyl ether. Two molecules of C_{19} aldehyde are condensed with acetylene *via* its Grignard or lithium derivative, and the resulting C_{40} diol is treated with alcoholic hydrogen chloride to cause allylic rearrangement and dehydration. The 15 : 15′-dehydro-β-carotene (VII) crystallizes out well and is easily separated from all by-products. Catalytic hydrogenation with Lindlar's catalyst and isomerization at 80° (both with the crystalline carotenoids in suspension in petroleum) complete the synthesis of β-carotene.

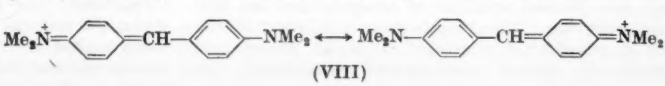
From the C_{40} diol with lithium aluminium hydride (an application of the Nayler–Whiting reaction) crystalline 7 : 7′-dihydro-β-carotene is obtained in more than 80 per cent yield.

Dr. Isler then outlined syntheses of zeaxanthin and physalien, which can be achieved on similar lines to that of β-carotene. Several alternative routes to β-carotene were also described.

In a synthesis of lycopene, use was made of the Wittig reaction. Geranyl bromide, from linalool, is added to triphenylphosphine, and the phosphonium bromide converted with phenyl lithium to geranylidenetriphenylphosphine, which is condensed with crocetindialdehyde to yield crystalline lycopene. The crocetindialdehyde is obtained by starting from acetylene and α-methacraldehyde, which yield a C_{10} dialdehyde. Chains are added at each end with ethyl vinyl ether and then ethyl propenyl ether, via the aldehyde acetals, and the final step is semi-hydrogenation of the central triple bond of the C_{20} dialdehyde to yield crocetindialdehyde.

Dr. Isler concluded with a tribute to his team in Basle, and he quoted Sir Ian Heilbron to the effect that with the overcoming of the major synthetical problems of carotenoid chemistry, it should now be the turn of the biochemist to help uncover the role of the carotenoids in the living cell.

Prof. Dewar began by illustrating how ideas of quantum theory provide a qualitative understanding of the relation between colour and constitution. A molecule such as that of hydrol blue (VIII), for which two classical structures of identical energy can be written, will be a hybrid or superposition of these structures. Its wave-function, ψ, will be a combination of those (φ_1 and φ_2) of the individual structures,



(VIII)

and two values can be derived, one ($\psi_1 = \varphi_1 + \varphi_2$) representing a ground-state of lower energy than either interacting structure alone, and a second ($\psi_2 = \varphi_1 - \varphi_2$) of higher energy. The molecule will, of course, normally exist in the ground-state, but may be excited to the higher one by absorption of light of appropriate frequency. Where two possible classical structures for a molecule differ in energy, the energy difference between ground- and excited-states becomes greater, and such a dye will absorb at a shorter wave-length than otherwise.

These ideas have been successfully extended to the cyanine dyes, which can be represented as $\dot{A}.—B \longleftrightarrow A—.\dot{B}$. The more chemically similar the end groups A and B are, the less will the position of the absorption band deviate from the mean position of those for the two symmetrical dyes $A—A$ and $B—B$. The Brooker deviation series provides a striking confirmation.

Prof. Dewar also mentioned how these ideas explain the solvent effect on the position of absorption bands. There is nevertheless a flaw in the treatment, because interaction of pairs of classical structures can only take place through a series of intermediate structures. Analysis of the resonance between the complete set of structures is mathematically very difficult; but calculations have been done and they justify the conclusions of the simpler treatment. Easier to apply is the molecular orbital method, which has met with considerable success in accounting quantitatively rather than qualitatively for the colour of cyanine and other cationic or anionic dyes. Prof. Dewar elaborated the 'free electron molecular orbital' approach, pointed out its limitations and successes, and went on to describe the 'perturbation molecular orbital' method. This is capable of accounting quantitatively for the light absorptions of aromatic hydrocarbons, as well as of cyanines, and related basic, acidic and azo dyes.

The relation between colour and constitution for the vat dyes, however, is much more difficult to interpret and possibly requires the development of more precise theoretical methods.

The papers of the symposium, with bibliographies, will be published by the Chemical Society, London, in *Special Publication* No. 4; this will include an account of the discussions, which were tape-recorded.

J. A. Elvidge

OBITUARIES

Dr. H. E. Woodman

Herbert Ernest Woodman died on February 13 at the age of sixty-six. He had been on the staff of the School of Agriculture at Cambridge for thirty-six years and was well known to generations of undergraduates. He was a leading authority on animal nutrition in Great Britain.

After graduating at the University of Leeds, he spent another year working under Prof. J. B. Cohen in the Chemistry Department there. He was then awarded an 1851 Exhibition and spent two years at Göttingen under Prof. O. Wallach, working on the terpenes, and he received the degree of Ph.D. in 1914. Later that year he joined the Animal Nutrition Research Institute, then at Leeds. He was awarded the D.Sc. degree of Leeds in 1921. Woodman at first worked with C. Crowther on the nitrogen metabolism of the dairy cow, and later with H. W. Dudley on the origin of the proteins in milk. This work established the identity of euglobulin and pseudoglobulin, whether from serum or colostrum, but showed that lactalbumin and serum albumin were two distinct proteins. When the Institute was transferred to Cambridge in 1920, Woodman went with it. He was appointed University demonstrator in October 1926, University lecturer in October 1930, and reader in animal nutrition in 1950.

In the early 'twenties, ensilage was rapidly gaining adherents in Britain, but there was a complete lack of knowledge of the magnitude and nature of the chemical changes occurring in the silo. Woodman, therefore, in conjunction with A. Amos, carried out a detailed and systematic investigation of the conditions responsible for the production of different types of silage and devised methods of analysis that are still in common use. The results were published in the form of a bulletin ("Ensilage", Bull. 37, Ministry of Agriculture), which was revised periodically by Woodman, and proved a great boon to the practical farmer as well as to the teacher.

In 1925, Woodman, with the encouragement of Prof. T. B. Wood, gathered together a team of young scientists to secure information concerning the nutritive value of pastures. This work continued over a period of twelve years and became a classic. It involved the determination of yield of dry matter, chemical composition, digestibility for sheep and pigs and the starch equivalent and protein equivalent per acre when the pasture was subjected to varying systems of management. A noteworthy finding was that young grass is a protein-rich concentrate, comparable in some respects with linseed cake. Living in Cambridge, with its lawns and playing fields, Woodman was attracted by the idea and possibility of the preservation of young grass for winter feeding by artificial drying. He carried out pioneer work in this field, and the present flourishing crop-drying industry is a tribute to this early work. Afterwards, investigations were made into the effect of management on the nutritive value of other forage crops like lucerne and kale. This information proved of inestimable value during the war years.

Woodman was the author of about 170 scientific papers covering a wide range of subjects. He made a valuable contribution to our knowledge of such diverse subjects as sheep nutrition, the nutritive value of sugar beet by-products and the mechanism of cellulose digestion in the ruminant.

In 1930 Woodman and I published our first joint paper, the forerunner of many more, during a close research partnership that lasted more than twenty-five years. In 1936, the first of a series of eighteen papers on the nutrition of the bacon pig appeared. Great stress was laid in this paper on experimental technique and the importance of designing an experiment so that the results could be analysed statistically. It was shown that an individual-feeding trial could

be four times as accurate as a corresponding group-feeding trial. The question of the protein requirements of pigs received early consideration. It was demonstrated that equally good results could be obtained, from the point of view of growth, economy of food conversion and carcass quality, when all-meal rations supplying only 7 per cent of white-fish meal were fed, as with diets much richer in protein. Moreover, it was shown that if the protein-rich concentrate was omitted altogether from the diet after 90 lb. live-weight, it was without the slightest effect on the rate of live-weight gain or on the leanness of the carcass. Considerable economies were therefore possible in the use of white-fish meal, which proved of great importance when supplies were short. The replacement of animal protein by vegetable protein plus minerals was also investigated.

On the death of Prof. T. B. Wood in 1930, Woodman became responsible for the sixth edition of "Rations for Livestock", the best-seller among the *Bulletins* of the Ministry of Agriculture. It became imperative in 1948 that the *Bulletin* should be almost entirely rewritten, and from this date Woodman assumed full responsibility as author. Woodman was also the author of the other bulletins—"Home Grown Feeding Stuffs" and "The Use of Oil Cakes and Extracted Meals"—which have lately been out of print. Finally, mention should be made of his contributions to *Agriculture*, during the War, of "Notes on Feeding Stuffs", which gave the results of research work at Cambridge and elsewhere, and were greatly appreciated by farmers and others.

No account of the work of Woodman would be complete without reference to his ability as a teacher. His great joy in life was in lecturing to the degree class at Cambridge. He was a born teacher and took infinite pains in the presentation of the material and had the gift of making a difficult subject seem easy.

He leaves a widow, a son and daughter, and a grandson.

R. E. Evans

Dr. H. Wormald

Harry Wormald, who died at his Maidstone home on December 10 last at the age of seventy-six, was distinguished for his pioneer work, over the past forty-five years, on the pathology of fruits and hops, and more particularly for his original researches on the two important groups of diseases, brown rot (*Sclerotinia* spp.) and bacterial canker (*Pseudomonas mors-prunorum* and *Ps. prunicola* Worm.), in both of which fields he became an authority of international repute.

Born a Yorkshireman, he first trained as a school-teacher and for eight years taught a general curriculum in schools in Bradford and Leeds. It was therefore not until he was thirty years of age, in 1908, that with a Board of Education scholarship he went to London to read botany at the Royal College of Science (Imperial College of Science and Technology) under Prof. J. B. Farmer. Three years later he gained his A.R.C.S. and also the B.Sc. degree of the University of London with honours; and after a further year of research at the Royal College of Science, when he was awarded the diploma of the College, he went in 1911 to Wye College in Kent (University of London) as assistant in the Botany (Mycology) Department under E. S. Salmon. The dominating interest in fungal and bacterial diseases of fruits and hops which Wormald developed at Wye is reflected in the award of the D.Sc. degree in 1919 for his early publications on brown rot, and in his transfer in 1923 to the then young East Malling Research Station as the first head of its Plant Pathology Section. There he worked for twenty-two years under the inspiring directorship of R. G. Hatton, and as the beloved chief and mentor of a long succession of postgraduate students and colleagues. It was at East Malling that Wormald consolidated his early work on the brown rot and crown gall diseases, and initiated the brilliantly original etiological studies on the bacterial canker diseases of the stone fruits.

In 1936 Wormald was appointed assistant director at East Malling, and for ten years, from 1935, he edited the Station's Annual Report. In 1940 he became president of the British Mycological Society and was joint editor of the *Transactions* of that Society during 1931–45. He also served as a member of the Council of the Association of Applied Biologists (1937–39) and as a vice-president (1938–39).

In 1945, in his sixty-sixth year, Wormald finally retired from East Malling, and in the same year joined the staff of the Commonwealth Bureau of Horticulture and Plantation Crops, stationed at East Malling, where for seven years he exercised his linguistic gifts (he could translate fluently from seven languages, including Russian) as an abstractor of world horticultural literature.

In 1952, at the age of seventy-three, Wormald was obliged to retire from the Bureau because of the illness to which three years later he was to succumb, only, however, to continue at home, with the quiet and patient tenacity of purpose which characterized his whole research career, the preparation of new editions of his two principal works, the monograph "The Brown Rot Diseases of Fruit Trees" (Ministry of Agriculture and Fisheries), and the standard text-book on his subject, embracing the impressive corpus of his original research papers, "The Diseases of Fruits and Hops" (Crosby Lockwood and Son, Ltd.). With the devoted and unflagging support of his wife, these immense tasks were brought to a successful conclusion, and within six months of the publication of the new edition of his text-book he died.

R. V. Harris

Mr. F. W. K. Gervers

Frank Walter Kitchener Gervers was born on April 17, 1920. He went to school at Bradfield, where he became an enthusiastic member of the School Natural History Society and published a paper of unusual quality for a schoolboy on the biology of a small stream. When he left school in 1939 he followed a family tradition and joined the Regular Army. He served in the Royal Artillery in North Africa, Italy and India; but his active military career was terminated by ill-health in 1946 and he decided to resume his interest in biology.

Gervers went to the University of Glasgow and during vacations worked in the laboratories at Pitlochry, Aberdeen and Lowestoft, and went to sea on the research vessels. After graduating he worked for a year with Dr. H. D. Slack on the biology of Loch Lomond, studying particularly the white fish or powan found there. In 1953, he joined the fresh-water fisheries staff of the Ministry of Agriculture and Fisheries and carried out a most useful study of the food of coarse fish. He also took a large part in the

work on the migration of sea trout and had begun an investigation into racial characteristics of salmon. His death on the last day of October 1955 deprived all who knew him of a much-valued friend and cut short a scientific career of great promise. He left a widow and two small children to whom he was devoted, and we extend our deepest sympathy to them.

F. T. K. Pentelow

[A communication of which he was part-author appears on p. 664 of this issue of *Nature*.]

NEWS and VIEWS

Refractories Technology at Sheffield : Prof. J. White

The firm of J. and J. Dyson, Ltd., of Stannington, manufacturers of refractory materials, has given £15,000 to the University of Sheffield for the establishment of a chair in refractories technology, which the University has named the Dyson chair of refractories technology, and Dr. James White, reader in ceramics in the University, has been appointed the first holder. After graduating in physical chemistry from the University of Glasgow in 1931, Dr. White did metallurgical research at the Royal Technical College, Glasgow, and later became lecturer in metallurgy there. In 1939 he was awarded the Carnegie Gold Medal of the Iron and Steel Institute. He left the College in 1943 to become head of research of General Refractories, Ltd., and three years later went to the University of Sheffield as senior lecturer in refractory materials, being appointed reader in ceramics in 1952. Dr. White has published a large number of research papers and is a recognized authority on the chemistry of ceramics and refractory materials. The creation of the new chair, which is the first such one to be established in Great Britain, and of a separate department specializing in the subject, should do much to further the advancement of knowledge in a field of great importance to the steel industry of Britain, and especially the industries of the Sheffield district.

Botanical Survey of India : Dr. G. S. Puri

Dr. G. S. Puri, formerly ecologist at the Forest Research Institute, Dehra Dun, has been appointed regional botanist-in-charge of the northern circle of the Botanical Survey of India. In 1938 he came under the influence of Dr. R. R. Stewart and joined him in the explorations of the Kashmir, Hazara and Murree Hills, and collected extensively. In 1940, at the invitation of Prof. B. Sahni, he joined the Botanical Department of the University of Lucknow and worked on the flora of the Karewa formations of Kashmir, for which he was awarded the Ruchi Ram Sahni Prize for the best research in the University. He has conducted extensive geological and botanical explorations in the Kashmir Himalayas and discovered fossiliferous strata. During 1942–45 he worked on the correlation of oil-bearing strata in the Assam Tertiaries by micro-fossils for the Burmah Oil Co., Ltd., a pioneer work in India. In 1945 he was selected by the Government of India for training abroad in ecology and systematic botany and worked in the University of London under Prof. W. H. Pearsall. He is secretary of the Indian Council of Ecological Research and the Society of Tropical Ecology.

Research at Fort Dunlop, Birmingham : Mr. E. A. Murphy

Mr. E. A. Murphy, general development manager at the Research Centre, Fort Dunlop, Birmingham, has been appointed director of research in charge of the central research division of the Dunlop organization. Mr. Murphy, who, for his services to the rubber industry, has been awarded the Colwyn Medal by the Institution of the Rubber Industry, joined the Dunlop chemical laboratories during the First World War. One of the activities of the general development division set up under him during the Second World War was the investigation of synthetic rubber manufacture. A pilot plant was then started and this led to the designing of the experimental plant for synthetic rubber production now being erected at the Research Centre, which has enabled Dunlop to take the leading part in the project for the large-scale manufacture of synthetic rubber in Britain by the recently formed International Synthetic Rubber Company.

Government Pressures on the Press

The International Press Institute, Zurich, has published as Survey No. 4 a study on "Government Pressures on the Press", which displays clearly but objectively the gravity of attacks that have been made on the freedom of the Press, even outside the totalitarian States, and the dependence of effective defence against such attacks upon an informed public opinion. The reasons which may lead even a liberal-minded government to desire the Press to exercise some restraint on publication are fairly indicated; it is emphasized that the Press is not above the law and that, although ideally the freedom of the Press should be complete, in practice this has to be qualified, nor can governments be indicted for not tolerating attacks which might endanger their existence. The first part of the study analyses pressures based on the law, the second those of an economic, administrative or purely political nature, and the third part in particular shows that the scientific and technical Press is no more immune from such pressures than the newspapers. The Institute is particularly concerned about the situation in South Africa, and especially because of the public apathy to successive government enactments during the past five years which have made the position of the Press there most precarious. In Australia and in India there are restrictive laws which are potentially dangerous; though they are not likely to be so applied by present or viable governments. The value of the study lies in the assembly of a large amount of factual material in convenient form and in indicating the nature and causes of the present threats to freedom of the Press. By and large, they arise less from the spread of illiberalism than from the growth of government and the domain of official policy in a divided and uneasy world.

National Research Development Corporation of India : Report for 1954–55

The National Research Development Corporation of India was registered on December 31, 1953, its main function being to stimulate the development of

patents and inventions arising out of researches conducted in research institutions financed out of public funds and, where feasible in the public interest, of patented inventions from individuals also. The Corporation has an authorized capital of Rs. 1 crore, and the late Sir Shanti Bhatnagar was an original member of its board of seven directors, of whom S. K. Lalbhai is chairman. Its first annual report (pp. 17; from the Corporation, New Delhi), to which are appended the statement of accounts and the objects of the Corporation as set forth in the articles of association, covers the period ended March 31, 1955, a period in which 177 inventions from twenty-four institutions and eight private individuals were reported for development. Trials have been arranged of a process for the manufacture of paper from wattle-wood, and negotiations were in progress for trials of processes for the manufacture of newsprint and cheap printing-paper from bamboo and for the de-ionization of cane-sugar; licences have also been negotiated for ten other processes. Processes for the manufacture of writing and printing paper from bagasse, for the recovery of nickel and fat from spent hydrogenation catalyst of vanaspati (vegetable oil) factories and for myrobalan extract in the myrobing of East Indian tannage of skins and kips have been made available to industry without any conditions regarding payment of royalties, and 62 processes are under critical examination. Normally the Corporation proposes to take 30 per cent of the gross earnings from premiums and royalties and pay 70 per cent to the research institutions.

Technical Education in Britain

In reply to questions in the House of Commons on March 20, the Secretary of State for Scotland said that in central institutions in Scotland there are about five hundred full-time and a thousand part-time teachers of technical subjects, of whom some three hundred full-time and twenty part-time teachers are doing work of approximately university level; and in other institutions of further education there are 650 full-time and 5,100 part-time teachers of technical subjects. Education authority projects in preparation include local technical colleges at Aberdeen, Dundee, Kilmarnock, Clydebank, Inverness, Motherwell and Bathgate, and three at Edinburgh; a schedule of accommodation has been approved for local technical colleges at Ayr and Falkirk, and projects which have been started include a local technical college at Paisley, Lauder Technical College, Dunfermline, Stow College of Printing, Glasgow, and Lees Castle College, Ross and Cromarty. Projects at central technical institutions expected to start in the next two years include internal adaptations and new premises for the School of Navigation at the Royal Technical College, Glasgow, and extensions to Paisley Technical College, to the Pharmacy Department of Heriot-Watt College, Edinburgh, and to Robert Gordon's Technical College, Aberdeen.

Society for Analytical Chemistry

The eighty-second annual general meeting of the Society for Analytical Chemistry was held in London on February 29, when the financial statement and the report of the Council for the past year were submitted and approved. The membership of the Society was reported as 1,842, an increase of 43 since last year. During the year the Society organized six ordinary meetings in London (three of which were organized by the Society's subject groups), and the first joint meeting with the Association of Public Analysts was held in Cardiff; in addition, the Society's Sections and Groups held thirty-seven meetings. A special meeting was held in London on November 29, when Prof. J. Heyrovský, an honorary member of the Society, gave a lecture entitled "The Development of Polarographic Analysis". The following officers and members of Council were elected for the forthcoming year: *President*, K. A. Williams; *Past Presidents serving on the Council*, Lewis Eynon, D. W. Kent-Jones, J. R. Nicholls and Georg › Taylor; *Vice-Presidents*, D. C. Garratt, J. Haslam and H. M. N. H. Irving; *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, N. L. Allport; *Honorary Assistant Secretary*, R. E. Stuckey; *Other Members of Council*, S. G. Burgess, R. C. Chirnside, C. H. R. Gentry, W. C. Johnson, D. D. Moir, T. McLachlan, R. F. Milton, Miss Mamie Olliver, F. C. J. Poulton, S. A. Price, A. A. Smales and A. F. Williams; *Ex-officio Members*, J. R. Walmsley (chairman, North of England Section), F. J. Elliott (chairman, Scottish Section), P. J. C. Haywood (chairman, Western Section), J. R. Leech (chairman, Midlands Section), G. F. Hodsman (chairman, Microchemistry Group), J. E. Page (chairman, Physical Methods Group) and K. L. Smith (chairman, Biological Methods Group).

The Relation of Pure to Applied Research in Agriculture

The annual general meeting on February 29 of the Society for Analytical Chemistry was followed by the Bernard Dyer Memorial Lecture, which this year was given by Sir William Slater, secretary of the Agricultural Research Council, his subject being entitled "The Evolution of Agricultural Research". Sir William stressed that agriculture is an industry and that consequently a worker in agricultural research has to combine the qualifications of a scientist with an understanding of farmers and their problems. The growth of research institutes in which pure investigations are possible as well as the development of practical applications, and the academic prestige attached to pure research, have led to a growing tendency for universities to encourage graduates to look to pure rather than to applied research for a career. Since the Second World War the difficulty of recruiting workers to applied research has been augmented by the increasing complexity and cost of the apparatus required for such research. In agriculture there is also the problem of providing facilities for work on farm animals. Nevertheless, pure research has brought about great changes in agricultural practice, and Sir William cited the example of the modern use of hormone weedkillers. New techniques such as the use of radioactive tracers offer possibilities for taking the work further. Sir William pointed out that it is necessary to have an intermediary who can explain to the farmer what the pure research worker has discovered in the laboratory and help in the application of the knowledge on the farm, and for this the National Agricultural Advisory Service has its specialist advisory officers, who work together with the district and county officers. But such men are all too few, and there is a need for a body of similar workers based on the research institutes. Looking into the future, Sir William sees two groups working together in the agricultural research institutes: one going ever deeper into specialized investigations in the laboratory, and the other devoting itself to the immediate solution of the

applied problems of the industry and maintaining contact with the Advisory Service and the farmers.

Giornale di Microbiologia: New Italian Journal of Microbiology

The editorial board of a new Italian journal, the *Giornale di Microbiologia* (edited from the Istituto di Patologia, Via Sant'Andrea delle Dame 8, Napoli; 2,500 lire per vol. for home subscribers, and 3,000 lire for foreign), intends to collect, from the international field, only original papers which have general microbiological importance and which will interest not merely people concerned with curative and preventive medicine, but also biologists and biochemists. Specialization, says the preface to this first issue, increases, but there is also a technical and theoretical integration of the various branches of science, and works of synthesis and analysis are needed more by microbiology than by the older, more precisely delimited, sciences. This first issue begins with a paper by H. Schmidt, of the Behring Institute for Experimental Therapy, Marburg, on the problem of allergy. R. Haas and H. Wolff, of the same Institute, contribute a paper on the culture of three strains of the influenza virus on ferret kidney cells. P. Lépine, of the Pasteur Institute, Paris, writes on vaccination for poliomyelitis. E. Baldacci and A. Grein, of the Institute of Plant Pathology, University of Milan, discuss the form of the spore of *Actinomycetes* as studied by the electron microscope and the classification of the forms seen; this paper is illustrated by remarkable photographs.

T. Scotti and P. Zocchi contribute a paper, also illustrated by photographs, on the structure of the mycelium of *Streptomyces aureofaciens*. R. Tulasne, T. Terranova and J. Lavillaureux, of the Institute of Bacterial Biology of the Faculty of Medicine, Strasbourg, claim that B-vitamins, especially riboflavin, can be used instead of horse serum or ascitic fluid to obtain either L-forms of certain Gram-negative bacteria or stable cultures of L-colonies already formed. A paper by C. Castagnoli, P. Donini and F. Graziosi, of the Institute of Physics and the Microbiological Institute, University of Rome, discusses some biophysical aspects of inactivation of the BM phage through decay of assimilated phosphorus-32. M. Teti, of the Institute of General Pathology, University of Naples, discusses the effects of ultra-violet radiation on a non-inductable lysogenic strain of *Escherichia coli*; and G. Cavallo, of the same Institute, reports on the sensibility to non-ionizing radiation of a temperate phage obtained from a lysogenic strain of *Micrococcus pyogenes*. The issue ends with a paper, illustrated by photographs, by G. A. Maccacaro and A. Angelotti, of the Institute of General Pathology, University of Milan, on their electron microscope study of the filaments of *Escherichia coli*. All the papers have short English summaries. The journal is well printed and attractively produced, its photographic illustrations being particularly commendable.

Radio Noise of Terrestrial Origin: Report of the International Commission

The eleventh General Assembly of the International Scientific Radio Union was held in The Hague during August 23–September 2, 1954 (see *Nature*, 176, 451; 1955), and Part 4 of the proceedings dealing with the meetings of Commission 4, on Radio Noise of Terrestrial Origin, under the chairmanship of Mr. J. A. Ratcliffe, has now been published (pp. 60; from the General Secretary of the Union, 42 Rue des Minimes, Brussels; 60 Belg. fr., 8*s*. 8*d*., or 1.20 dollars). In accordance with the practice of this Union, the reports of national committees on work related to the Commission are published in full, but reference to the other scientific papers submitted is limited to a list of titles and authors. A paper presented by Mr. Ratcliffe deals with the question: "What are the most easily measured characteristics of Terrestrial Radio Noise from which the interference to different types of communication systems can be determined?" This question, which was discussed at a joint meeting with Commission 6, on Radio Astronomy, defines the scope of an investigation of great scientific and practical importance; and a working party was set up to examine the problem in more detail. Some of the recommendations made at the Assembly contain suggestions for continuing research on atmospherics during the forthcoming International Geophysical Year and for the preparation of revised charts showing the general level of atmospheric noise all over the world and its variation with time and season. In view of the great importance of this work to radio communication, the Union maintains close co-operation with the International Radio Consultative Committee in this field.

History of Polish Science

Despite the difficulties of finance and printing, the output of scientific books and periodicals in post-war Poland has been remarkably large and the standard of the publications impressively high. Apart from numerous new journals and text-books devoted to advances of modern science, the Polish Academy of Science has brought out during the past few years several new monumental monographs devoted specifically to the history of scientific developments in ancient and modern Poland. The most recent addition to this series is Vol. 2 of the "Studies and Materials from the History of Polish Science" ("Studia i Materjały z Dziejów Nauki Polskiej". Pp. 881. Warsaw: Polska Akademia Nauk, 1954). Of the eighteen papers which compose this volume, about half are devoted to Polish science of the sixteenth and seventeenth centuries. Three essays deal exclusively with Copernicus (Kopernik) and contain a most interesting and striking analysis of his ideas and their influence on the development of modern physics and mathematics.

Modern Development of Commercial Pesticides

A handsome illustrated brochure, entitled "Fifteen Years of Geigy Pest Control", has been published by the Geigy Co., Ltd., Manchester (pp. 150; n.p.), which gives a clear account of Geigy's work on products for pest control and the way it developed out of mothproofing agents into insecticides, seed disinfectants, timber preservatives, etc. The brochure displays the many purposes for which dichlorodiphenyltrichloroethane and like products are now used and also describes its pharmacology and toxicology, its physics and chemistry, and mode of action. Besides describing these DDT insecticides and their importance, the brochure outlines recent work in this field by the Geigy Co., including that on repellants, the control of resistant flies and mosquitoes, systemic insecticides, selective acaricides, rodenticides, and on weedkillers such as 'Gesin' and the parathion preparation 'Etilon' which originated outside Geigy's laboratories. This part of the

brochure is provided with a good bibliography and will be highly useful to the technical worker. The part describing the development of such products, including the experimental farm at Pfeffingen, and their marketing is of more general interest. The brochure as a whole gives an impressive picture of the way in which these products have been intensively developed in little more than a decade.

Physical Society's Exhibition

THE Physical Society's annual Exhibition of Scientific Instruments and Apparatus will be held in the Old and New Halls of the Royal Horticultural Society, London, S.W.1, on the following dates: May 14, 10.30 a.m.–8 p.m. (members and Press only, 10.30 a.m.–2 p.m.); May 15 and 16, 10 a.m.–8 p.m.; May 17, 10 a.m.–5 p.m. The size of the Exhibition is expected to be similar to that of last year, but the use of the Old Hall will give extra space and make for easier access. A greater number of universities, colleges and research organizations will be taking part this year, thus increasing the proportion of purely research exhibits. The discourses this year will be as follows (each one at 6.15 p.m.): May 14, "Recent Developments in Light Sources", by Mr. H. G. Jenkins (Research Laboratories of the General Electric Co., Ltd.); May 15, "The Production of Images of Chemical Molecules", by Prof. H. Lipson (Faculty of Technology, University of Manchester); and May 16, "Colour Television: Considerations which have led to Recent Trends", by Mr. G. G. Gouriet (Research Laboratories of the British Broadcasting Corporation). As in previous years, the Society is publishing a "Handbook of Scientific Instruments and Apparatus" in connexion with the Exhibition (6*s*., or 7*s*. 6*d*. by post). All inquiries should be sent to the Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Announcements

DR. PAUL R. BURKHOLDER, discoverer of the micro-organism that produces the antibiotic chloromycetin, has been appointed director of research at the Brooklyn Botanic Garden, New York. He will take up his new duties on July 1. Dr. Burkholder is at present head of the Department of Bacteriology at the University of Georgia, Athens, Georgia.

PROF. H. C. LONGUET-HIGGINS, Plummer professor of theoretical chemistry in the University of Cambridge, has been appointed Arthur D. Little visiting professor of chemistry in the Massachusetts Institute of Technology. During his three-months stay he will give a series of lectures on the application to chemistry of modern physical theories of atomic and molecular structure. Dr. Edwin H. Land, president of the Polaroid Corporation, has been appointed the first Fellow of the newly established School for Advanced Study at the Massachusetts Institute of Technology. The offices of the Polaroid Corporation are near the Institute, and Dr. Land will give part-time services to the educational and research activities of the Institute.

THE National Vegetable Research Station, Wellesbourne, Warwick, is holding its first open day on June 5. Applications for invitations should be sent to the Station.

Two Ramsay Memorial Fellowships, normally tenable for two years and worth £600 a year plus a grant for expenses of research not exceeding £160 a year, are being offered for chemical research. One of the Fellowships will be limited to candidates educated in Glasgow. Full information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom application forms must be sent not later than April 20.

AN autumn course in nuclear engineering, for graduates wishing to take up the subject, will be held at Queen Mary College, London, during September 3–October 12. Lectures will be given on nuclear physics, heat transmission, reactor theory, materials for nuclear reactors, instrumentation associated with reactors, health physics, shielding of reactors, reactor design, fuel technology, reactor kinetics and the control of reactors. Application forms, to be completed by June 1, and further information can be obtained from Dr. R. F. Saxe, Queen Mary College, Mile End Road, London, E.1.

THE Ninth International Congress of Applied Mechanics will be held in the University of Brussels during September 5–13, under the presidency of Prof. F. van den Dungen, professor of analytical mechanics in the University. The technical sessions of the Congress will be in two sections: fluid dynamics and aerodynamics; and mechanics of solids (rigid dynamics, vibrations, elasticity and plasticity). The official languages of the Congress will be English and French. Those wishing to participate should register before June 30. Application forms and further information can be obtained from the general secretary of the Congress, J. Vandenkerckhove, University, 50 Avenue F.-D. Roosevelt, Brussels.

THE Fifteenth International Congress of Pure and Applied Chemistry (Analytical Chemistry) will be held in Lisbon during September 9–16. The following subjects will be considered: microchemical methods, biological methods, electrical methods, optical methods, radiochemical methods, organic complexes, statistical interpretation of results, adsorption and partition methods, general, and standardization of methods and miscellaneous applications. Circulars and entry forms are obtainable from Prof. P. A. Laurent, Instituto Superior Tecnico, Avenida Rovisco Pais, Lisbon, Portugal. British persons wishing to submit papers to the Congress should send summaries, not later than May 1, to the Secretary of the British National Committee for Chemistry, Royal Society, Burlington House, London, W.1.

THE Sixth International Spectroscopical Colloquium will be held in Amsterdam during May 14–19 under the auspices of the Koninklijke Nederlandse Chemische Vereniging and of the Nederlandse Natuurkundige Vereniging. Like former colloquia, this one will cover mainly emission spectroscopy (flame photometry, arc spectra, spark spectra and quantometry) and absorption spectroscopy (infra-red and Raman spectroscopy; ultra-violet, visible and fluorescence spectroscopy). In addition, there will be a session on instrumentation, and two evenings will be reserved for discussions on such problems as nomenclature, normalization and documentation (the use of punch-cards, etc.). An exhibition of instruments and scientific literature will also be held. Further information can be obtained from the Laboratorium voor Analytische Chemie, 125 Nieuwe Achtergracht, Amsterdam-C4.

RECENT SOVIET RESEARCH ON MICROBIOLOGY IN THE ARCTIC AND OTHER REGIONS

DURING recent years scientists in the U.S.S.R. have given much attention to various problems of research in the North Polar area, including those of microbiology, and this field alone forms the subject of three important articles by Dr. A. E. Kriss (*Vestnik Akad. Nauk SSSR*, No. 8, 23 (1954); No. 1, 30, and No. 9 (1955)). Among previous Russian work referred to is that of B. L. Isachenko 1908–14, recorded in a monograph, "Bacterial Studies in the Northern Arctic Ocean". Dr. Kriss discusses at some length the scientific significance of micro-organisms—their high and varied enzymatic activity (for example, as bio-catalysts in different reactions) in relation both to organic and inorganic constituents of seas and oceans, low forms of vegetation, and other manifestations both on the ocean floor and in the waters above. He describes some bacterial counts at different depths in the Black and Caspian Seas, with tables and illustrations showing varying density of population, at depths down to 2,000 m. or lower. Much of this work, including notes on the Pacific Ocean adjoining the Sea of Okhotsk, is based on earlier studies by M. N. Lebedeva, V. I. Biryuzova, E. A. Rukina, etc. The research is being continued in the Sebastopol and other biological stations.

Seasonal changes and density fluctuations have been studied, with the causes thereof, so far as these can be discovered. Similar work in the United States is criticized as yielding little satisfactory result because the test samples of water were taken directly on the shore (at the end of a pier) and studied by the culture method. Samples, say the Soviet workers, should be obtained at a sufficient distance from dry land and subjected to direct microscopical examination. A table gives comparative figures of bacterial counts per millilitre of water at three stations in the Black Sea at depths down to 2,000 m. as shown by colony counts and by direct microscopy. Vertical distribution and density are also shown diagrammatically for the 'bio-masses' of micro-organisms in the deep-water parts of the Black Sea down to 2,000 m. at five stations (Lebedeva); and in addition in the oxygen zone of the same Sea 30 miles from the shore, winter and summer, down to 200 m. The first of these diagrams shows considerable uniformity down to 2,000 m.; while the second indicates that during the summer there is a relatively large maximum at 25 m., decreasing rapidly to 75 m., after which it is fairly constant; and, for the winter, a similar but smaller decline—from the surface maximum, down to about 50 m., with gradual expansion to the initial maximum down to 150 m., followed by relative constancy to 250 m.

Among the results of these Black Sea and other studies is the evident indication that bacteria constitute the primary organic material and are here associated with phytoplankton. Quantitative determination of the whole mass of micro-organisms gives some idea of the extent of their work in mineralizing dead organic matter. Starting with the fact that one microbial cell requires for its development energy approximately equal to that of the decomposition of organic matter three times exceeding its own weight, it is possible from the magnitude of the bio-mass of micro-organisms to realize in some measure the amount of organic matter in sea-water subjected to mineralization.

But the methods hitherto used for determining bacterial life in marine waters have been unsatisfactory. A new method is described by Dr. Kriss, which, though still imperfect, is claimed to surpass others so far known. The method is related to direct microscopic examination and in essence consists in lowering to various depths microscopic slides that remain in position for a specified period and are then drawn up. After suitable treatment and staining, the number of micro-colonies forming on the slides and the number of cells in each are calculated. In this way, it is possible to estimate the rate of propagation of bacteria in a given stratum of sea-water. (Though Dr. Kriss claims this as a new method, it seems to be akin to the usual technique used by microbiologists; as he admits, it is imperfect, in that it gives preference to organisms that will settle on a glass surface, and neglects those that do not.) Some results obtained by this so-called 'glass overgrowth' method are described, and the significance of the ratio of micro-organism products to their biomass is discussed. The need is emphasized for taking into account the widely varying conditions of season and place; for example, as between coastal and open-sea localities and between winter and summer, including also the ocean-bed where accessible. Work in the waters of the Caspian Sea is again cited by way of example of what has been done in the Soviet Union. Among other things, it has been found that about half the microbial cells (Russian *kletka*) found in the sea-bed ooze are absorbed or digested by *Nereis siccinea* during passage of lumps or particles of ooze through the alimentary tract of this worm.

Much yet remains to be done in elucidating the complex relations or links between micro-organisms and phytoplankton or phytobentos (or the corresponding zoo-types); in the study of many biogenic substances in sea-water; in increasing our knowledge of bacterial bio-catalysis; and much else. It is interesting to note that, on the floor of the Black Sea at about maximum depth, considerably more organic material easily assimilable by micro-organisms is found than on the floor of the Okhotsk Sea, the difference between them being of the order of a thousandfold.

The need for better methods of study is again emphasized by Dr. Kriss, and some of the wider aspects of this research are indicated, for example, chemical nature and constitution of sea-water; the physical aspects such as the effect of high pressure or low temperatures, combined with study of the barophyllic organisms; and other departments of science. Recent research in the Pacific at depth, or even on its floor, shows that the barophyllic type may exist in vast quantities. Special forms include those of the hydrogen sulphide depths of the Black Sea that have lately been widely investigated by Soviet workers. Other matters briefly discussed are the effect of sea-water organisms on the corrosion of structural iron and steel and concrete, and the nature

and significance of marine microbial biocenoses (biocenogenesis ?).

In his second article, Dr. Kriss deals more specifically with Arctic conditions, and in addition to the earlier work of Isachenko he refers also to that of V. S. Butkevich during 1935 in the high latitudes from 82° 42′ almost to the north pole. No study at depth was undertaken, but only surface layers—presumably of ice or pack-ice. Kriss himself undertook two flights to the polar regions during July and September 1954, to establish the 'drift stations' of which the principal was called North Pole-3. Positions were lat. 88° 04·3′ N., long. 151° 16′ W., and lat. 89° 29·5′ N., long. 65° 43′ W.; the ocean depths were respectively 3,450 and 4,116 m. The July station was on the Pacific side of the Lomonosov submerged ridge, and that of September on the Atlantic side, and were thus of special interest. As already known, this ridge extends from the New Siberia islands through the north polar region to Greenland and Zembla Elsmir. In some parts of the Central Arctic, the height of these submarine mountains is more than 3,000 m.

The microbiological laboratory was set up in the hydrological building (hut or tent). Samples of water and soil were collected through holes in the ice, about 2 m. in diameter, using a special windlass made by the Arctic Institute and water-sampling bottles; also used was a core-sampler or tube designed by Alekseev (of the Arctic Institute) for ooze or mud cores. In July, samples of water were taken from the surface and at eighteen different depths down to 3,400 m. The surface water was obtained by separation near the ice floes. In September, the maximum depth was 3,700 m. In fact, the ocean floor was reached to get the cores.

The treatment of samples, filtering, preparation of cultures are described, and the results tabulated show for July and September 1954, respectively, at various depths down to 3,700 m., the number of colonies (per litre of water) and morphological state. For July, at the surface, there was continuous growth of bacilli (or rod-shaped bacteria), following which at the various depths there was considerable fluctuation in number of colonies: 1,120 at 10 m., 35 at 25 m., 490 at 75 m., 2,660 at 100 m. . . . 210 at 3,000 m., and nil at 3,400 m., in some cases with sporogenetic rods and in others with non-sporing rods (the latter being more frequent). For September, the count at the surface was of 525 colonies, with both sporing and non-sporing rods, cocci and yeasts; at 10 m. 1,995 non-sporing colonies; at 25 m. 2,485 sporing; at 50 m. 350 both sporing and non-sporing; at 150 m. 2,660, 200 m. 3,045, 300 m. 980, all non-sporing; . . . at 3,500 m. 350 sporing; and at 3,700 m. 140 non-sporing. Thus heterotrophic bacteria are found at practically all depths. It is interesting to note that at 750 m. in July the count was 70 and in September nil (the only depth in either month when the result was nil except, of course, at 3,400 m. and lower in July).

The samples of water were poured into sterilized flasks of 250 ml. into which had been previously placed narrow glass slides, and the flasks closed with ground stoppers; they were maintained for about a week at 5–7° C., and afterwards at 18–20° C. Bacterial growths—up to millions—are described; for example, from 350 colonies taken at 3,500 m. depth 5 million colonies resulted in relatively short time.

A second table gives cell counts per ml. at various depths of the north pole region during July and September and, for comparison, figures obtained from eleven out of the twenty-six stations of the north-western Pacific during May–July 1953 at depths down to 9,000 m. (for Station 26). In both cases the maxima this time are at or near the surface (50 m.) and then show a somewhat fluctuating but general decline (down to 33 counts/ml. at 8,500–9,000 m., Station 26). As might be expected, the Pacific figures are much larger, as a rule, than the north pole ones and are of the order of 100,000 to 400,000 counts/ml. from surface to 50 m. The Pacific stations were about 180–200 miles from the Kurile Islands and Kamchatka.

Methods of calculating the bio-mass content are described in a footnote, and the results given in a third table show average bio-mass of micro-organisms of usual form and cocci form—with thickened coatings—at the different depths down to 3,500 m. in the north polar region during July and September 1954, reckoned in mgm./cu. m. water. The cocci forms are 0·04 mgm. at the maximum depth up to about 0·12 at higher levels. The ordinary forms range from 0·005 mgm. at depth to 2–4 mgm. at or near the surface (0–50 m.). Some differences in form and type of organism are discussed for the north polar region as compared with the Pacific.

In regard to study of the ocean bottom near the north pole, Dr. Kriss observes that the top layer of ooze (0–2 cm.) was separated with all necessary precautions and placed in sterilized test-tubes, from which cultures were prepared, with different nutrients for the various types—inorganic salts with asparagine, calcium citrate, calcium lactate, honey, etc. The organisms included denitrifying and desulphurizing types. Reference is also made to a thionovic or thionic acid type (Russian: *tionovo-kisli*). From weighed portions of ooze suspensions were also prepared in the proportions 1/10, 1/100 and 1/200 in 0·0004 *N* sodium hydroxide spread—for direct microscope study by the Vinogradsk method—on slides to the extent of 6 sq. cm. and suitably treated for separation of the microbial forms. Rates of growth with different nutrients are noted, including also nitrite and nitrate formation, the behaviour of which was specially studied in various media. Reckoned on 1 gm. of natural ooze, microbial counts were 4–304 million for usual cells, and 170–400 million for the thick-walled cocci. Observation of these cultures from the ooze extended over three to five months.

It is thus shown that, close up to the north pole, micro-organisms exist under the perennial pack-ice practically at all levels in the water and on the bottom, with consequent continuous mineralization of organic matter and conversion of biogenic compounds; thus justifying the possibility of other forms of life, both vegetable and animal, in the highest latitudes of the Arctic region. The significance of this in connexion with general hydrological research is indicated.

The third paper by Dr. Kriss deals with a Russian expedition to the Arctic in the spring of 1955, in which leading biologists of the Soviet Union took part. It seems to have practically reached the north pole. Dr. Kriss, who accompanied the party, says that stations were established throughout the Central Arctic between latitudes 82° and 90°, including Drift Stations designated as North Pole 3 and North Pole 5. Among other things, from a hydrological point of view, the greater concentration of bacterial content in boundary or junction waters of different seas and oceans, or currents, was specially studied.

It was shown, for example, that at or near the upper and lower boundaries of Atlantic currents reaching the north polar area, the micro-organism population was several times larger than in the average of higher or lower levels.

Dr. Kriss presents some graphs showing the relation between depth (in metres) and micro-population at different seasons (June and September) as indicated by the two methods: filters, and glass overgrowth or submerged slides. There are substantial 'peak' differences with the two methods; for example, at about 100–150 m. and between 750 and 1,200 m. A map of the north polar region is also shown, giving the distribution of about 15 points where samples were taken from surface layers down to 4,000 m.

Nearly all the 1955 stations were on pack ice, and only two on the continental dip at depths of 900 and 1,850 m. Holes of 1–1·5 m. were drilled in the ice, and sampling bottles of the Nansen type were lowered to the different depths. It was evident that organisms on the ocean floor can exist under pressures up to several hundred atmospheres. It was possible in many cases to determine approximate rates of propagation at various depths. W. G. Cass

BIBLIOGRAPHY OF THE BAUXITE DEPOSITS OF THE WORLD

ALUMINIUM now competes with copper for second place after iron as the most widely used metal in commerce, and virtually all the pure alumina used for the manufacture of the metal, upwards of five million tons a year, is obtained by processing bauxite. This material is therefore an ore of the first importance, both commercially and strategically. Deposits are widespread throughout the world, though their distribution is somewhat capricious, at least from a strategic point of view. All the bauxite used by the aluminium industry in Britain is imported, and the deposits within the United States and Canada are insufficient to provide for the enormous consumption by the aluminium industry in North America.

Since Dr. C. S. Fox published, more than twenty years ago[1], a monograph on the subject containing an extensive bibliography, the literature on the subject has grown steadily. It is, however, scattered through the scientific and technical journals of many countries, so that the United States Geological Survey has fulfilled a real need by publishing a new "Annotated Bibliography of the Bauxite Deposits of the World", by Elizabeth C. Fischer (Geol. Survey Bull. 99. Pp. 221+1 folding map. Washington, D.C.: Government Printing Office, 1955; n.p.). This bibliography, which contains more than a thousand entries, was commenced originally for the use of the staff of the Survey and enlarged to meet the demand for information arising out of the greatly increased use of aluminium during the Second World War. It covers various aspects of the subject, including the origin, geology, mineralogy, chemistry, reserves and production of bauxite. A selection of papers on 'laterite' and 'lateritization' has been included, because these terms have often been used as synonyms for bauxite (that is, aluminous laterite) and the processes leading to its formation. On the other hand, accounts of the technical aspects of the mining and processing of bauxite have largely been excluded.

The entries are arranged alphabetically under authors' names, and the index is sub-divided into subject and locality headings so that references to any particular subject or area can be found quickly. There is also a useful world map showing the distribution of the principal bauxite deposits. The bibliography includes publications issued up to the end of 1950, only. Even so, it will prove extremely welcome to all interested in the subject, and it may be hoped it will be followed by a supplement.

V. A. Eyles

[1] "Bauxite and Aluminous Laterite", 2nd ed. (Crosby Lockwood and Son, London, 1932).

STRUCTURE OF FRONTS IN METEOROLOGY

THE conception of a 'front', a roughly plane, sloping zone dividing air masses of different origin with the warmer air below the colder air, is a fundamental one in meteorology. The major areas of deep cloud and precipitation over the British Isles are associated with fronts, and the word has thus become a familiar one to all listeners to the weather forecasts broadcast on the radio. A front is a warm front if warmer air replaces cold air as the front passes over any point, and the converse for a cold front. Until recently, knowledge of the structure of fronts was obtained from surface observations of temperature, humidity and cloud forms, from rather isolated 'vertical' aircraft ascents, and from observations obtained by balloon-borne instruments.

During 1950–52 the Meteorological Research Flight of the Meteorological Office made twenty-three flights from its base at South Farnborough to observe the cloud structure and the temperature and humidity variations along fixed levels approximately perpendicular to the front. The flights were made following plans decided on the basis of the synoptic charts drawn at the Central Forecast Office.

The observations, in conjunction with those of the nearly simultaneous radio-sonde ascents, are analysed by J. S. Sawyer in Geophysical Memoir 96 of the Air Ministry—Meteorological Office, entitled "The Free Atmosphere in the Vicinity of Fronts: Analysis of the Observations by the Meteorological Research Flight, 1950–52" (M.O. 584*d*. Pp. 24. London: H.M.S.O., 1955; 5*s*. net). The observations show a great complexity of structure, indicating that no simple idealized structure can adequately represent an individual front, but clearly confirm the existence of sloping regions of change between two roughly homogeneous air masses. Mr. Sawyer finds that, in the region between about 6,000 and 20,000 ft. explored in the flights, there were (*a*) a frontal region, varying from 200 to 1,000 miles in width, with an average of 600 miles, across which there was a temperature difference of 5–29 deg. F., average 15 deg. F., at a fixed height, and (*b*) within the frontal region a relatively narrow frontal zone of up to 250 miles in width, average 130 miles, with a temperature contrast up to 21 deg. F., average 9 deg. F. Frontal zones of less than 50 miles wide were uncommon. The slopes of the frontal zones varied between 1 and 250 and 1 in 30, with an average of 1 in 55. This slope is much steeper than the value of 1 in 100 stated in some text-books.

A hitherto unknown feature of frontal structure revealed by the flights was the existence of a tongue

of relatively dry air extending downwards along the frontal zone to an average height of about 6,000 ft. Mr. Sawyer shows that this tongue is produced, not by vertical motion down the front, but by horizontal advection of air the relative humidity of which had been reduced by descending motion some eighteen hours before in the ridge of high pressure ahead of the front. The change of humidity across a front is from moist warm air to cold dry air across a warm front, the rate of change of frost-point or dew-point being greater than that of temperature, and of a dry transition zone at cold fronts between two relatively moist air masses. The clouds observed were mainly stratiform in nature, with convectional cumulus clouds in places in all the cold fronts and in six of the seventeen warm or quasi-stationary fronts. The main cloud mass associated with the front was in the warm air, with little extension into the transition zone at nine of the twenty-three fronts examined, partly in the warm air and transition zone in seven of them; in only one was there a solid mass of cloud in the cold air.

PRESERVATION OF ANIMALS AND PLANTS BY DRYING FROM THE FROZEN STATE

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METHODS which are being used for the preservation (*a*) of the natural colours of animals and plants possessing labile pigments, and (*b*) of the natural shape of those which are soft-bodied, leave much to be desired. Bottled specimens preserved in alcohol or formalin take up a great deal of space, and neither these nor specimens preserved in resins or synthetic polymers are readily available for close examination. Dried skins are fragile, often they retain little of the natural colour and rarely reproduce accurately the shape or attitude of the original specimens. Insect larvæ, spiders, annelids, molluscs and fungi are among the most difficult forms of life to preserve satisfactorily for examination and exhibition.

Hard-bodied insects which have stable pigments, for example, most butterflies and moths, present no difficulty; but dragonflies, except those the colours of which are due to light interference by their surface structure, lose their colours rapidly after death. These colours can be preserved by drying *in vacuo* using a water pump[1] or very rapidly, preferably at low temperature, with a high-vacuum pump[2].

Soft-bodied insects cannot be preserved in this way; even if the pressure is lowered very gradually to prevent bursting, they finally dry in a shrunken shapeless form. This difficulty can be overcome by freeze-drying, which not only maintains the natural shape and size of specimens, but also is least damaging to their colouring materials.

Freeze-drying, introduced by Florsdorf and Mudd, has become the normal method for recovering biologically active large molecules from aqueous solutions[3]. Cooling due to the rapid vaporization of ice in a high vacuum is sufficient to maintain the frozen state when solutions are dried in an ordinary glass desiccator at room temperature if the depth of the solution does not exceed a few centimetres, and there is no restriction of the absorption or condensation of water vapour. More elaborate freeze-drying equipment incorporates a heater to prevent the temperature from falling too low and slowing the rate of evaporation unduly.

When the evaporation from the surface of a frozen object is restricted, there is insufficient cooling to maintain the frozen state; caterpillars fall into this category, since their integument protects them against the drying conditions of the environment. On the other hand, it has been found that animals which normally live in water or in very moist conditions, for example, fish and marine worms or slugs and earthworms, are unable to resist the egress of water vapour.

Caterpillars can be freeze-dried in the following way: specimens are killed with cyanide, weighed and placed in the bottom of a test-tube which is partly immersed in a mixture of acetone and solid carbon dioxide at − 65° C., where they become completely frozen in a few minutes. They are then placed in an ice-box at − 15° and their temperature allowed to rise to this point, where they are in no danger of thawing nor is their vapour pressure too low for reasonably rapid drying at the pressure obtainable with a good oil pump (10–25μ mercury). A glass desiccator containing phosphorus pentoxide is precooled to −15°, the specimens transferred to it and a high vacuum applied. Specimens up to 2 in. in length (300–500 mgm.) dry under these conditions overnight, and those weighing up to 5 gm. can be dried in a few days. During this process, 65–75 per cent of weight is lost; on re-exposure to the air 1–2 per cent of moisture is reabsorbed. By the nature of the process, the products retain their shape and form, they are hard but slightly flexible, and cannot be broken by pressing between the fingers, nor is the main structure damaged by dropping on a hard floor. Whereas the colour of most specimens was quite unimpaired, the transparency of the integument is lost; and in cases where the colouring is contributed to from within, as in some green caterpillars, the final appearance is not satisfactory. In some instances green specimens retained their colour, but in others where green survived the drying process, this colour faded in a few weeks even in a sealed tube of nitrogen in the dark. Apart from this difficulty, specimens have been stored after freeze-drying without deterioration for more than a year in a laboratory atmosphere, and there is no reason for supposing that their condition is not permanent under normal storage conditions. Their final state does not differ from that of some vacuum-dried dragonflies, which have retained their natural colours for ten years.

Until the rate of drying of a particular type of specimen has been determined, it is necessary to find when constant weight has been reached. Care must be exercised when handling incompletely dried specimens, which must not be touched except with forceps cooled well below 0°, to prevent local thawing.

otherwise a brown mark appears on the dried product. Rapid freezing at −65° is desirable, because slow freezing gives relatively large ice crystals which disrupt cells and body structures to give a more fragile product.

Spiders can be preserved very satisfactorily as dried specimens; they are generally less transparent objects than many insects, so that their natural colour and appearance remain quite unchanged. Difficulty was experienced initially in freezing spiders, due apparently to the presence of rather large amounts of fat in the body. When specimens were soaked overnight in trichloroethylene and then exposed to the air for the solvent to dry away, they could, however, be set on pieces of cork, frozen and dried *in vacuo* as already described.

Earthworms and slugs dried rapidly after freezing, but the dried products were opaque and white. This was due to the presence of mucous substances on their surfaces which could not be completely washed off. This difficulty has not been overcome; the specimens are perfect from the morphological point of view, but for exhibition purposes can only be recommended as better objects for colouring artificially than models. In the case of marine worms, the parapodia could be maintained in the extended condition by dropping specimens into a beaker containing ethanol at − 65° held in the acetone–carbon dioxide bath.

Although theoretically there is no limit to the size of animals which could be preserved by freeze-drying, the increasing ratio of volume to surface area in larger subjects imposes a practical limit. Among vertebrates, small fishes have been dried by freezing a dish full of water in which they were swimming and evaporating the whole contents of the dish to dryness. In this way the fins remain in an extended and natural position; however, like invertebrates which live in moist environments, the dried fishes were white and opaque. A pipistrelle bat presented no difficulty, and a mouse weighing 18 gm. dried successfully, losing 68 per cent of its weight. The mouse showed itself to have considerable protection against loss of water and took three weeks to dry; this does not make the process uneconomical, however, as a large number of specimens can be placed in one desiccator.

Of interest to botanists will be the observation that fungi are beautifully preserved in the dry state by this technique. A large toadstool weighing 30 gm. dried to constant weight in 24 hr. and became re-equilibrated to laboratory atmosphere on regaining only 2 per cent of its original weight. The greatest loss of water on drying was found among the fungi, some of which lost more than 90 per cent of their weight. It might be of interest to record in this connexion that the least loss to constant weight (50–54 per cent) was found with migratory locusts, which, on account of their relatively rigid structure, could be vacuum-dried at room temperature without freezing in 2–3 hr.

Although no deterioration has been detected after storing any specimens preserved by freeze-drying, it might be wise to inject a non-volatile disinfectant, before freezing, into those which are required for permanent collections.

[1] Moore, B. P., *Proc. S. Lond. Ent. Nat. Hist. Soc.*, 179 (1951).
[2] Davies, D. A. L., *Entomologist*, **87**, 34 (1954).
[3] Florsdorf, E. W., and Mudd, S., *J. Immunol.*, **29**, 389 (1935). Florsdorf, E. W., "Freeze Drying" (Reinhold Pub. Corp., New York, 1949).

A STIMULATORY ACTION OF INDOLE-3-ACETIC ACID ON THE UPTAKE OF AMINO-ACIDS BY PLANT CELLS

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IT is a striking fact that, although plant growth-regulating substances produce many profound and far-reaching effects on plant cells, yet when they have been applied to animal cells little or no effect has been demonstrated. A recent report by Christensen, Riggs and Coyne[1] that indole-3-acetic acid (in relatively high concentration) stimulated the accumulation of amino-acids by mouse tumour cells was therefore of especial interest, and led us to investigate whether the auxin acts similarly on the uptake of amino-acids by plant cells.

Etiolated sunflower seedlings, six days old, were used in this investigation. Segments 1 cm. long were cut from the hypocotyls at a distance of a centimetre below the crook, and, after being washed in distilled water, were suspended in briskly aerated, buffered solutions of radioactive amino-acids, which were uniformly labelled with carbon-14. After periods varying from 0·5 to 3·5 hr. the segments were removed, well rinsed with distilled water, and freeze-dried. Their radioactivity was then determined by a technique involving wet combustion.

A very marked increase in the amount of carbon-14 incorporated from solutions of glutamic acid and glycine has been observed when indole-3-acetic acid is present in the medium. Typical experiments are summarized in Table 1. This response to auxin is a rapid one, being clearly apparent in experiments lasting less than 30 min. As Table 1 indicates, it is produced by physiological concentrations of indole-3-acetic acid. Further experiments have shown that the curve relating magnitude of effect to auxin concentration closely follows that for extension growth. The stimulation is dependent on the presence of oxygen: under nitrogen, although the figure for carbon-14 incorporation reaches approximately two-thirds of that for aerated solutions, the auxin effect is abolished.

In these experiments the uptake of glutamic acid was accompanied by the uptake of water from the surrounding medium. Water uptake was, of course, considerably greater in the presence of auxin, leading to a gain in fresh weight of approximately 13 per cent during a 2-hr. experiment as compared with

Table 1. THE EFFECT OF INDOLE-3-ACETIC ACID ON THE ACCUMULATION OF CARBON-14 FROM SOLUTIONS OF UNIFORMLY-LABELLED AMINO-ACIDS BY SEGMENTS OF SUNFLOWER HYPOCOTYL

Experiment	Experimental conditions	Indole-3-acetic acid concentration	Specific activity of segments (mμc. per m.mole carbon)†	Per cent increase in specific activity produced by indole-3-acetic acid
I. Glutamic acid 10^{-2} *M*	16 segments* in 3 ml. for 2 hr.	0	10·3, 11·1	
		$8{\cdot}6\times10^{-6}$ *M*	17·5, 19·3	72
II. Glutamic acid $2{\cdot}1\times10^{-3}$ *M*	12 segments* in 2 ml. for 2·25 hr.	0	53·4, 53·8	
		$2{\cdot}9\times10^{-5}$ *M*	81·7, 92·3	62
III. Glycine 2×10^{-3} *M*	12 segments* in 3 ml. for 2 hr.	0	47·4, 43·2	
		$2{\cdot}9\times10^{-4}$ *M*	59·7, 69·5	43

* The fresh weight of 10 segments is approximately 280 mgm.
† The carbon content of the segments was not perceptibly affected by the treatments.

3–4 per cent in the absence of auxin. To discover whether the uptake of water and the uptake of glutamic acid were in any way linked, experiments were carried out in which net water uptake was reduced or eliminated by the addition of mannitol to the external medium. It was found that the presence of mannitol did not depress, but on the contrary slightly enhanced, carbon-14 accumulation by segments not treated with auxin. The percentage increase in carbon-14 accumulation produced by auxin was, however, markedly diminished. It thus appears that, at least in the absence of auxin, there is no direct connexion between the uptake of water and the uptake of glutamic acid. The reduction in the auxin-induced stimulation of amino-acid uptake is possibly connected with the arrest of cell extension, which may prevent auxin from exerting its full effect.

In further experiments extracts of the segments were made at the conclusion of the experiment and their radioactive compounds examined by chromatographic techniques, using both filter paper and 'Dowex-50' columns as described by Moore and Stein[2]. It was found that only about 30 per cent of the radioactivity of an alcoholic extract is in the form of glutamic acid. No marked difference in the level of glutamic acid has been observed between auxin-treated and control segments. Colorimetric determinations revealed that the native level of glutamic acid is very low in this tissue, of the order of 25 μgm. per gm. fresh weight or less. It may be that the balance of the reactions involving glutamic acid in these cells is such that the concentration of free glutamic acid is always very low. Thus any glutamic acid entering the cells, whether in the presence or absence of auxin, is immediately metabolized. The free glutamic acid which is detected in the samples at the end of the experiments may, in fact, be recovered from the intercellular spaces and cell walls, not from the cytoplasm itself.

Table 2. EFFECT OF INDOLE-3-ACETIC ACID ON THE QUANTITY AND SPECIFIC ACTIVITY OF CO_2 EVOLVED BY SEGMENTS OF SUNFLOWER HYPOCOTYL BATHED IN SOLUTIONS OF UNIFORMLY-LABELLED GLUTAMIC ACID

(11·2 gm. tissue samples in 125 ml. 2×10^{-3} *M* glutamic acid for 2 hr.)

Treatment	μMoles CO_2 evolved	Specific activity of CO_2 (mμc. per m.mole carbon)
No indole-3-acetic acid	185	783
	185	750
$2{\cdot}9\times10^{-4}$ *M* indole-3-acetic acid	230	936
	247	878

Under the conditions of this investigation the rate of respiration of auxin-treated segments was enhanced by 20–30 per cent. When the carbon dioxide evolved was collected, precipitated as barium carbonate, and tested for radioactivity it was found that the specific activity, too, was decidedly higher in the case of the auxin-treated tissue. A typical experiment showing this interesting result is summarized in Table 2. It will be seen that, not only was the amount of carbon dioxide evolved 29 per cent higher in the presence of auxin, but this carbon dioxide was 18 per cent richer in carbon-14. It follows, therefore, that treatment with auxin had brought about a 52 per cent increase in the amount of glutamic acid respired, while only raising the all-over rate of respiration by 29 per cent.

The results reported here indicate that auxin influences the amount of amino-acids entering the cell from the surrounding medium. In the animal cells referred to earlier[1] it is thought that indole-3-acetic acid achieves its effect through its action on a transfer process. No such transfer mechanism is definitely known to exist in the plant tissue investigated here. Arisz[3] has reported active transport of amino-acids in certain highly specialized organs, the tentacles of *Drosera capensis*. Webster[4] has shown that respiratory inhibitors depress carbon-14 accumulation by bean hypocotyls bathed in solutions of labelled amino-acids; but this action may be indirect. While it seems probable, therefore, that in these cells, as in the animal cells, indole-3-acetic acid stimulates the active transfer of amino-acids (either into the cell or into some specific region of it) other possibilities have to be considered. Amino-acids may, for example, penetrate by diffusion against a considerable resistance, and auxin may bring about a lessening of this resistance. Again, it is possible that auxin does not act directly on the entry of the amino-acids: it may stimulate one or more of the processes which remove free amino-acids within the cell and which are thus responsible for maintaining an inward diffusion gradient for the acid. Should this be the correct explanation, the respiration experiment (Table 2) is significant. In the presence of auxin, glutamic acid formed a larger proportion of the substrate respired. One possible explanation is that under these conditions more glutamic acid reached the respiratory centres—that is, that auxin directly facilitated the uptake of the acid. But an alternative explanation is that glutamic acid was preferentially respired in the auxin-treated segments. This would suggest a special connexion between the action of auxin and the respiration of amino-acids (or of some derivative of amino-acids within the cell).

A fuller account of this investigation will be published elsewhere.

We wish to express our appreciation of the encouragement given us by Prof. G. E. Blackman, director of this Unit. [Feb. 24

[1] Christensen, H. M., Riggs, T. R., and Coyne, B. A., *J. Biol Chem.*, **209**, 413 (1954).
[2] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **192**, 663 (1951).
[3] Arisz, W. H., *Acta Bot. Neer.*, II, 74 (1953).
[4] Webster, G. C., *Plant Physiol.*, **29**, 382 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron Microscopic Observations on the Secondary Wall of the Protoxylem of *Cucurbita*

During an examination of the sieve plates of *Cucurbita* already briefly reported[1], some observations on the structure of the secondary wall in the protoxylem have been made which seem worth recording.

Since the early work of Crüger[2] a number of later workers have recorded the close relationship between the structure of the cytoplasm and the pattern of thickening in annular and spiral vessel segments.

Barkley[3] has described the development of the secondary wall in the protoxylem of *Trichosanthes anguina*, a member of the Cucurbitaceæ. According to her account the cytoplasm of differentiating vessel segments shows a banded structure, due to the development of rows of vacuoles lying between bands of cytoplasm which remains denser. The vacuoles separating the cytoplasmic bands in annular vessels are larger than those in spiral ones. During ontogeny of the vessels, the bands of cytoplasm lay down the secondary cellulose wall which then undergoes lignification. Sinnott and Bloch[4] observed a similar behaviour in *Coleus* during regeneration from parenchyma after wounding. Majumdar[5], working with *Heracleum sphondylium*, recorded additional observations on the development of the secondary wall; according to him, development of the secondary wall is preceded by the deposition of pectinaceous bases on which the secondary wall is then laid down. These bases are said to prevent the secondary wall from making intimate contact with the primary wall.

The sections presented here (Figs. 1 and 2) show the detailed structure of the secondary wall as seen in longitudinal section. Examination of these does not show the pronounced bases by which the secondary wall is said to be attached to the primary one. Although there is some indication of the lenticular-shaped base, this is very small and does not seem to prevent the secondary wall layers from making contact with the primary wall. The primary wall, due to stretching, is very thin and shows no detailed structure. The cellulose lamellæ of the secondary wall, however, are very clear (Fig. 2) and seem to be laid down in concentric rings of increasing radius. The several lamellæ appear to be firmly held together by a ground substance which may be lignin.

The lamellæ indicate, of course, the position of the cytoplasm at the

Fig. 1. Electron micrograph of longitudinal section of one wall of a protoxylem vessel element (× 3,400). Methacrylate removed. Shadowed palladium–gold. Note the thin primary wall with the superposed (presumably spiral) secondary thickenings

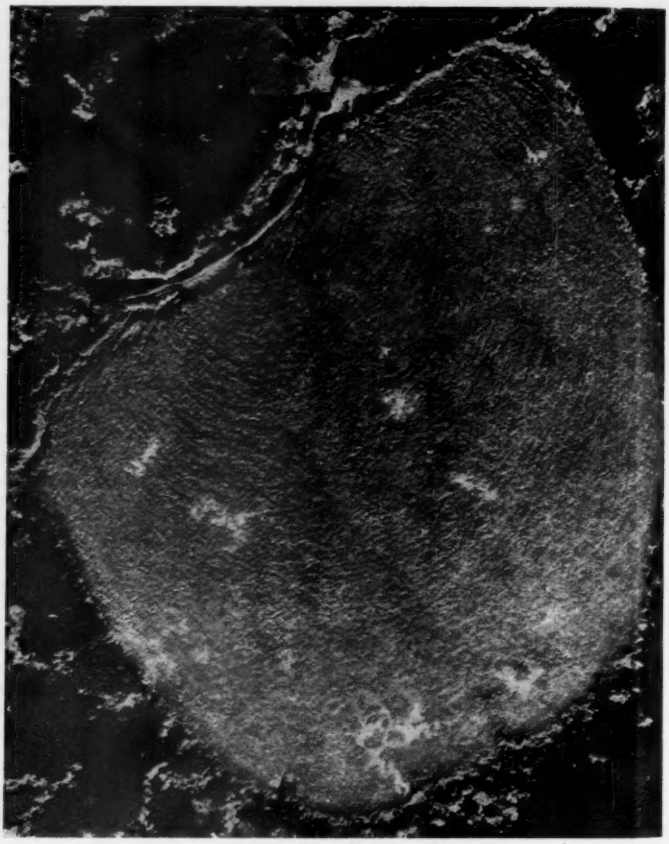

Fig. 2. Enlarged detail of Fig. 1. (× 14,400)

moment of deposition. The photograph therefore shows most clearly the enormous local expansion of the cytoplasm during the deposition of these thickening bars.

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[1] Hepton, C. E. L., Preston, R. D., and Ripley, G. W., *Nature*, **176**, 868 (1955).
[2] Crüger, H., *Bot. Z.*, **13**, 601 (1855).
[3] Barkley, G., *Bot. Gaz.*, **83**, 173 (1927).
[4] Sinnot, E. W., and Bloch, R., *Amer. J. Bot.*, **32**, 151 (1945).
[5] Majumdar, G. P., *Proc. Leeds Phil. Soc.*, **3**, 642 (1940).

Uptake of Radioactive Phosphorus by Larvæ and Adults of Mosquitoes

Eight batches of twenty-five second instar larvæ of *Aedes aegypti* were immersed in separate beakers filled with a radioactive bath composed of 30 ml. tap water and progressively increasing amounts of a solution of radioactive disodium hydrogen phosphate ($Na_2H^{32}PO_4$). The concentrations of the radio-isotope ranged from 17 to 4,480 mμc./ml. Rolled oats (0·25 gm.) was added to each beaker to serve as larval food. Larvæ in baths with a concentration of 17–68 mμc. of phosphorus-32 showed the earliest (seven days from the day of immersion) and highest frequency of emergence as adults (approximately 60 per cent). Larvæ in baths with progressively higher concentrations of the radioisotope showed a delayed pupation, though at the end of two weeks most of the larvæ in all baths pupated except for the bath with the concentration of phosphorus-32 amounting to 4,480 mμc./ml. In concentration up to 140 mμc./ml., the emergence from pupæ took place on the average within 48 hr. after pupation, and there was a considerable mortality of emerged or half-emerged adults. This mortality was roughly proportional to the concentration of the radioactive isotope in the larval bath.

Larvæ in the bath with a concentration of phosphorus-32 amounting to 2,240 mμc./ml. remained apparently normal for more than three weeks but produced dead pupæ.

After two weeks, it was found that a very considerable proportion of radioactivity was adsorbed by the remaining larval food and debris.

The viable adults were collected each day with a suction tube, killed with chloroform vapour, dried for 24 hr. in the desiccator, weighed and their radioactivity assessed with regard to a standard reference day (day 10) of the life-cycle. The results of this investigation are shown in Table 1.

The resulting radioactivity of the adult was related to the concentration of the larval bath. It appeared that concentrations exceeding about 100 mμc./ml. of the larval bath were injurious to *A. aegypti* in so far as they greatly decreased the number of the emerged adults. The amount of radioactivity shown by the adult female was proportionately greater than in the male. While the female was on the average 1·6 times heavier than the male, the amount of radioactivity exhibited by her was about 2·5 times higher.

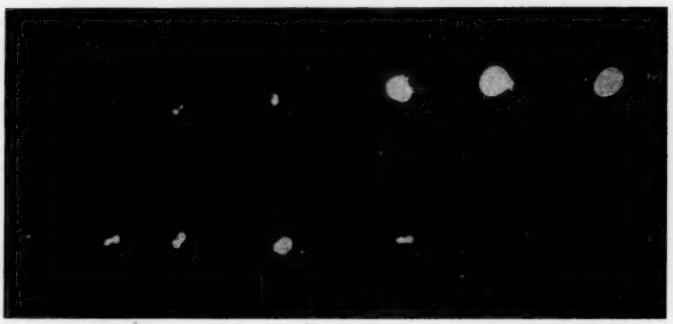

Fig. 1. Autoradiographs of a series of adult *A. aegypti* labelled with phosphorus-32 and exhibiting varying radioactivities. Males: 0·9, 1·8, 2·8, 4·2, 20·0, 32·0, 71·0 mμc. Females: 2·0, 4·3, 6·2, 16·2, 12 mμc.

Emerged adults were, after drying, mounted with 'Durofix' on a lead-rubber sheet, covered with a thin 'Cellophane' sheet and autoradiographed in a standard exposure holder on 'Kodak Crystalex' X-ray film. The time of the exposure varied between 4 and 18 hr. Autoradiographs, indicating clearly the radioactive mosquitoes and roughly the amount of their radioactivity, were obtained. A mosquito with radioactivity corresponding to 1 mμc. is clearly shown on

Table 1. Amount of Radioactivity of Adult Mosquitoes produced from Larvæ kept in Various Concentrations of Phosphorus-32

Beaker	Concentration of phosphorus-32 in larval bath (mμc./ml.)	Mean day of emergence	Mean day of counting	Sex	Numbers	Mean dry weight of mosquito (mgm.)	Mean counts per minute	Mean radioactivity of mosquito (mμc.)
Control	0	10 10	11 11	M F	12 10	5 5	1 1	0 0
2	17	10 10	11 11	M F	10 9	5 7	532 1,400	0·8 2·0
3	34	10 10	11 11	M F	5 6	6 10	1,206 2,871	1·7 4·1
4	68	10 10	11 11	M F	6 7	5 9	2,043 3,533	2·9 5·1
5	140	10 10	12 12	M F	4 3	3 7	2,767 8,642	4·0 12·4
7	560	10 10	11 11	M F	6 4	5 9	14,426 12,882	20·6 18·5
8	1,120	10	11	M	5	6	40,975	58·5
9	2,240	12	13	M	1	5	50,167	71·7

the film after 12–16 hr. exposure (see Fig. 1). About five hundred mosquitoes can be mounted on the 8 in. × 10 in. standard film, and it is suggested that this simple method of detection of labelled insects might be of value for qualitative ecological studies, such as investigation of the range of flight. This is of particular interest in tropical areas where electronic equipment is not available in field conditions.

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Nutritional Aspects of *Mortierella hygrophila* Linn.

Physiological studies on micro-organisms regularly isolated from soil profiles may lead eventually to a clearer interpretation of the ecological relationships of these organisms. To this end studies were initiated on the nutrition of a species of *Mortierella*. Although members of this genus are consistently isolated from soils, little is known of their nutrition.

A strain of *Mortierella hygrophila* Linn. was kindly supplied by Mrs. Turner of the Botany Department, University of Nottingham (Uni. Nott. No. 11—isolated by Claussen), and a single-spore isolation was made. The subsequent culture was employed in experiments and a subculture has been deposited at the Commonwealth Mycological Institute, Kew (Herb. I.M.I. No. 50115). Cultures were maintained on potato carrot agar, and washed-spore suspensions were employed as inoculum at a concentration of 50,000 spores/flask.

The composition of the basal culture medium was: carbohydrate source, 5,000 mgm. C; nitrogen source, 500 mgm. N; K_2HPO_4, 1·0 gm.; $MgSO_4.7H_2O$, 0·5 gm.; $FeCl_3$, 0·02 gm.; 1 ml. micro-element solution, supplying the following concentration of trace metals per litre: iron, 0·2 mgm.; zinc, 0·18 mgm.; copper, 0·04 mgm.; manganese, 0·02 mgm.; molybdenum, 0·02 mgm., twice glass-distilled water to 1 l. All chemicals were 'Analar' grade and sugars were supplied by Kerfoot and B.D.H.; *p*H initially adjusted to 6·0–6·5.

Cultures were grown in 25-ml. medium in 100-ml. Erlenmeyer flasks, and mycelial felts were washed and dried overnight at 75° C. The results were expressed as the mean weight in milligrams of five replicates.

With glucose as the source of carbohydrate the utilization of various sources of nitrogen is shown in Table 1. No growth was obtained with sodium nitrate as the source of nitrogen. However, the incorporation of 0·2 per cent yeast extract ('Difco') into the medium appeared to result in a partial utilization of the nitrate-nitrogen. Further investigation showed that the addition of small quantities of yeast extract or of peptone in a glucose medium resulted in an increase in mycelial weight above the weight due to the nitrogen content of the additions alone (Table 2).

This effect did not appear to result from a growth-factor requirement because no stimulation of growth was recorded when the following vitamins were employed singly and in combination: thiamin, riboflavine, pyridoxine, calcium pantothenate, nicotinic acid, ascorbic acid, *p*-amino-benzoic acid, biotin and inositol. No growth response was noted when yeast extract was ashed and added to a sucrose–nitrate medium. Various amino-acids were added to a glucose–nitrate medium at a concentration of 0·016 gm. acid per cent. Some growth resulted with almost all, the relative growth-rates being: L-arginine, DL-alanine, > DL-ornithine, L-glutamic, aspartic acid, asparagine, glycine, L-cystine, L-tyrosine, > DL-threonine, L-histidine, > DL-phenyl alanine, DL-valine, DL-methionine, DL-*nor*leucine, and none on DL-tryptophan. At best, growth was not as good as with peptone. Apparently there was no indispensable amino-acid.

Table 1

Nitrogen source	Mycelial weight on: Basal medium + glucose	Basal medium + glucose + 0·2 per cent yeast extract	Basal medium + sucrose + 0·2 per cent yeast extract
$NaNO_3$	0·0	102·1	77·2
$NH_4H_2PO_4$	14·6	75·8	20·3
$(NH_4)_2SO_4$	9·6	65·3	14·9
NH_4NO_3	9·2	81·1	13·7
Glycine	36·5	115·8	18·0
Peptone	147·3	141·6	140·2
Yeast extract 0·2 per cent	81·9	—	—

Table 2

Source of nitrogen	Mycelial weight on basal medium + glucose
$NaNO_3$	0·0
Yeast extract, 0·2 per cent	88·2
$NaNO_3$ + yeast extract, 0·2 per cent	161·7
Peptone, 0·1 gm.	62·7
$NaNO_3$ + peptone, 0·1 gm.	94·9
Peptone, 0·01 gm.	6·4
$NaNO_3$ + peptone, 0·01 gm.	23·0

The replacement of glucose with sucrose in the basal medium plus yeast extract provided a similar pattern of nitrogen utilization (Table 1).

In order to utilize nitrate-nitrogen, *M. hygrophila* may require a source of preformed nitrogen compounds to provide sufficient energy for the production of an adaptive nitrate reductase enzyme. This explanation appears to be only partially true because with decreasing peptone additions mycelial weights also decrease.

The availability of various sources of carbohydrate to *M. hygrophila* was determined on a medium containing sodium nitrate and 0·2 per cent yeast extract. The results are shown in Table 3.

Table 3

Carbohydrate source	Mycelial weight on basal medium + $NaNO_3$ + 0·2 per cent yeast extract
Glucose	106·9
Maltose	87·2
Raffinose	25·3
Lactose	24·5
Sucrose	20·9
Arabinose	17·5
Starch	32·6
Glycogen	20·2

Macerated, washed Whatman No. 50 filter paper was added to the basal medium containing sodium nitrate and yeast extract to test for possible cellulolytic activity. *M. hygrophila* was not able to grow on this medium, even when 0·05 per cent 'starter' glucose was added.

This work was carried out during the tenure of a research fellowship in the University of Nottingham.

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Eggs of *Lestinogomphus africanus* (Fraser)

In June 1955 I had the good fortune to obtain batches of eggs from two females of the archaic dragonfly *Lestinogomphus africanus* (Fraser) taken near Kuru, Northern Nigeria. These eggs presented a feature which has apparently not hitherto been described in the Odonata, although similar structures are known in certain genera of the Ephemeroptera. The posterior pole of the egg was produced into a coiled filament about 30 mm. in length, at first tightly wound and forming a small cap over the end of the egg, but opening out into a loose spiral on contact with the water.

A fuller description of the egg and of the early nymphal stages will shortly be published elsewhere by myself and Mr. A. E. Gardner, who has reared some of these eggs up to the third instar, so no further details are necessary here.

Morgan[1] described and figured very similar structures in the egg of the mayfly *Stenonema*, and these have been discussed by Needham, Traver and Hsu[2]. They are generally considered to be an adaptation to life in rapidly flowing water and to serve for anchorage, although eggs both with and without special anchoring structures can be laid in both rapid streams and quiet ponds.

Dr. P. S. Corbet, of Jinja, Uganda, informs me that he has very recently obtained some eggs from *Ictinogomphus ferox* (Rambur) and finds that they have filaments similar to those shown in some sketches of *Lestinogomphus* eggs that I had sent him; it therefore appears possible that these filaments may be found in a number of different genera of the Gomphidae. Dr. Corbet has found fully grown nymphs of both *Lestinogomphus* and *Ictinogomphus* in sheltered muddy portions of lakes in Uganda, and considers that the presence of these filaments may be evidence of rheophilic ancestry in species at present able to live in a stagnant and muddy environment. In Nigeria, *Ictinogomphus* breeds in muddy ponds; but the *Lestinogomphus* in question were taken beside a flowing stream, so it would appear that the latter species is able to breed in both running and stagnant water.

I am grateful to Dr. Corbet for permission to quote his observations.

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Dec. 3.

[1] Morgan, A. H., *Ann. Ent. Soc. Amer.*, **6**, 371 (1931).
[2] Needham, J. G., Traver, J. R., and Hsu, Y.-C., "The Biology of Mayflies" (Ithaca, New York, 1935).

Ink Ejection by Cephalopoda

It has long been said that the ink discharged by the great majority of cephalopods is ejected as a black cloud, under cover of which the animal may escape from a threatened attack. That this is false is apparent to anyone who has watched the phenomenon. The ink (of such cephalopods that I have seen) initially does not form a cloud, but remains a discrete, dark, viscous mass; water turbulence breaks up the mass, dispersing it in the form of streaks indicating the direction of the current flow, and even in a small volume of water such as an aquarium tank, cloud formation takes place only after some considerable time. The importance of this may not be readily apparent in a brightly illuminated aquarium; but the following observation, made under conditions of reduced light intensity one evening aboard the Singapore Regional Fisheries Research Vessel *Manihine* (October 1955), appears to present the true interpretation of this escape reaction.

I attempted to catch a small (unidentified) squid, some three inches long, which was being kept alive in a large, light-coloured wooden tub. The squid displayed evidence of agitation as it was manœuvred into a suitable position for capture, changing colour rapidly in the manner which is well known. When my hand was within about nine inches of the animal the squid assumed a dark coloration and appeared to become stationary. I seized the dark object, but it proved to be nothing more than a volume of ink; the squid was found to be at the opposite side of the tub. On repeating the attempted capture, I was able to see that, after assuming the dark coloration, the squid discharged a quantity of ink sufficient to produce a discoloured volume of water of similar size to the squid itself, simultaneously becoming pale in colour and moving away rapidly around the perimeter of the tub. Although I had been anticipating a discharge of ink during the first attempted capture, so efficiently had the operation been performed, and so intent had I been on the capture of a dark-coloured creature, that I had failed completely to see the escape of the squid in its light-coloured guise. I had the advantage of viewing the events laterally: a 'natural' enemy would have suffered the additional complication of having the ink discharged between it and the squid.

I have not yet had the opportunity of comparing with this the behaviour of other cephalopods, but in the case of the specimen examined the important features of the escape reaction are: (1) the assumption of a dark coloration immediately before (2) the discharge of a quantity of ink sufficient only to discolour a volume of water of similar size to the animal itself, this ink functioning primarily as a decoy, but also masking to some extent (3) the rapid change of the animal to a lighter colour and (4) the rapid departure of the animal from the scene of the impending attack.

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Variation in Mortality with Differences in Humidity among Mosquitoes exposed to BHC, Dieldrin and DDT

Since 1949 a long series of trials of residual insecticides has been carried out by this Unit at Taveta, Kenya, using the trap-hut method originated by Thompson[1]. In a number of the trials carried out since 1952, using BHC and dieldrin, a pronounced seasonal effect has been observed. During the dry season, the percentage mortality among female anophelines entering the houses has frequently declined, increasing comparatively rapidly at the onset of the next rainy season. This has been noted in huts lined with an impervious surface (banana leaf) treated with dieldrin and in others with reed roofs

Table 1. Percentage Mortality among Female *A. gambiae* and *A. funestus* suspended in Cages in Three Huts treated with Insecticide

Date 1954–55			Oct. 13–14	Nov. 23–24	Dec. 16–17	Feb. 7–8	Feb. 28–Mar. 1	Mar. 28–29
Rain in previous week (in.)			0·33	0	0	3·15	0	1·40
Hut No.	Insecticide	Position						
1	BHC	Wall	64	50	0	100	18	100
		Middle	0	32	16	100	12	100
2	BHC	Wall	0	10	0	100	0	100
		Middle	0	24	0	53	0	73
3	Dieldrin	Wall	0	0	0	100	0	100
		Middle	0	0	0	44	0	—
4	Control	Wall	0	0	0	0	0	0
		Middle	0	0	0	23	0	0

Table 2. Percentage Mortality of Female *Anophelines* suspended in Cages in Hut 3 (treated with Dieldrin) during Early Rainy Season 1955

Date	Mar. 11–19	20	21	22	23	24	25	26	27	28	29	30	31	Apr. 1	2	3	4	5	6	7	8–11
Rain (in.)	0	1·20			0·6	0·35	0·25	0·20													No
Mortality (per cent)	0	0	46	75	80	100	100	100	95	100	60	100	83	19	14	90	94	0	16	0	tests

Date	Apr. 12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	May 1	2	3	4
Rain (in.)	0·6	0·3										0·5											1·15
Mortality (per cent)		100	100	60	0	0	47	56	40	100	84	100	32	76	42	100	95	90	100	80	31	0	57

Date	May 5	6	7	8	9	10	11	12	13	14
Rain (in.)			0·5	0·45		0·14	0·45			
Mortality (per cent)	67	70	—	100	–	100	45	100	42	20

and walls plastered with mud, and treated with either dieldrin or BHC. The phenomenon has not been noted with DDT in this series of trials; but it possibly occurred in the earlier set conducted in the same locality by Davidson (ref. 2, Table 3) using DDT oil-bound suspension on a mud-and-gravel wall. Hocking[3] observed an increase in kills in a tent treated with DDT dissolved in kerosene when heavy rain fell, but his observation seems to have been overlooked.

It is suspected that rising atmospheric humidity is the reason for increasing mortalities in our trials. Throughout these experiments, regular tests have been made with blooded female *Anopheles gambiae* and *A. funestus* suspended in the huts in gauze cages. One cage has been fixed so that one side is about ¼ in. from a wall but not touching it; the other has been hung from the roof, about 5 ft. from walls or thatch. The results of a series of tests in three huts, all with mud walls, during the period October 1954–March 1955 are given in Table 1. This period comprises the short rains, short dry season and beginning of the long rains; but the season in question was remarkable for heavy unseasonal rains between February 2–8. Table 1 gives the percentage mortality of female vectors for each date, together with the total rain recorded during the previous week one mile distant at the offices of Taveta Sisal Estate, Ltd., to which I am indebted for these figures.

The kill in the huts treated with BHC during November 23–24 is probably due to increased humidity preceding 2·52 in. of rain during November 25–27. Apart from these two entries, the relation between rain and high mortalities is consistent.

These observations were followed by daily exposure of mosquitoes in the hut treated with dieldrin. These results are given in Table 2. Direct readings of relative humidity were commenced; but the hygrograph used was afterwards found to be unserviceable. As the rainy season becomes established, the relation between precipitation and mortality becomes less intimate, consonant with the generally high level of humidity at this season.

These experiments measure only the vapour or, in the case of dieldrin, particulate action of the insecticide[4], and similar results have been obtained with dieldrin in Mexico by Bordas and Navarro[5]. However, the seasonal variation among mosquitoes entering the huts naturally, which is mentioned above, has been detected in huts no longer showing any vapour or particulate action, and evidently the effect is also apparent in mosquitoes contaminated by direct contact. A detailed account of the experiments will be submitted for publication elsewhere; but the purpose of this communication is to direct attention to a factor which may have important practical effects in two ways. First, an insecticide-spraying routine which is quite adequate in a coastal or forest area with constant high humidity may fail when applied in a dry inland zone where breeding of anophelines takes place in river pools, irrigation water or artificial containers. Secondly, when conducting tests to determine the persistence of a treatment, or to detect possible acquired resistance to insecticides, misleading results are possible unless test conditions are standardized with regard to humidity.

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Jan. 6.

[1] Thompson, R. C. Muirhead, *Trans. Roy. Soc. Trop. Med. Hyg.*, **43**, 401 (1950).
[2] Davidson, G., *Bull. Ent. Res.*, **44**, 231 (1953).
[3] Hocking, K. S. H., *Trans. Roy. Soc. Trop. Med. Hyg.*, **40**, 589 (1947).
[4] Davidson, G., and Burnett, G. F., *Nature*, **170**, 893 (1952).
[5] Bordas, E., and Navarro, L., *WHO* (Insecticides), 38 (Geneva, 1955).

Occurrence of *Achtheres percarum* Nordmann in English Waters

Achtheres percarum Nordmann[1] is a copepod crustacean well known as an ectoparasite in the buccal cavity and on the gills of perch, pike and pike-perch from Germany, Italy, Czechoslovakia, Finland and the U.S.S.R. as far east as Lake Baikal. Until recently, however, there has been no authentic record of it in the British Isles. Gurney[2] pointed out that T. and A. Scott's record[3] of it in the Ray Society

monograph on British Parasitic Copepoda was an error due to a misidentification of specimens of *Salmincola thymalli* (a parasite of trout).

It was therefore of considerable interest to find that parasites taken from the mouth of a perch from the Kennet and Avon Canal at Burfield by Mr. S. Prudhoe on June 17, 1954, belonged to this species, and in November, quite independently, one of us (F. W. K. G.) found them, also on perch, in the River Colne, near Rickmansworth, two fish trapped during an investigation of the food of coarse fish being infected. Further samples from three stations, covering six miles of the River Colne and Grand Union Canal system, confirmed that perch were the only hosts of this parasite. Pike, roach and gudgeon were also present but not attacked. Among the small number of perch examined (240 specimens) the overall percentage of infected fish from the three stations investigated was 7½ per cent.

Seven per cent of the perch were infected at the highest station (*A*) in the River Colne, just before its entry into the Grand Union Canal two-thirds of a mile above Rickmansworth. Below Rickmansworth the old course of the River Colne forms a series of intermittent channels linked with the Grand Union Canal. In one such channel at the second station (*B*) two and a half miles below station (*A*) and immediately before its reunion with the canal at the sewage works near Maple Cross, no fewer than 27 per cent of the perch population were infected. Three and a half miles farther down at station (*C*), in the Colne near Denham Studios, one hundred and twenty-four perch were examined and found entirely free from this parasite.

All sizes of perch (10·0–32·0 cm. in length) were attacked by the parasite; but the percentage was much greater among the larger fish (longer than 14·0 cm.).

Individual hosts frequently bore one or two parasites, but the larger parasitized fish (more than 20·0 cm.) had two or more and in one case ten parasites per host. According to Schäperclaus[4], the number of parasites per host is much greater on the Continent of Europe.

In perch from the River Colne the parasite was only found in the buccal cavity and never on the exterior of the body. In some cases the parasite attached itself to the gill bars, rakers or palate, but was most frequently found on the edge or tip of the tongue, where the parasite would seem most vulnerable to damage when the host is feeding.

There is the possibility that *Achtheres percarum* Nordmann has been accidentally introduced into Britain with perch, pike or pike-perch, all of which, according to records available since 1937, have been imported intermittently into south England in small numbers from Holland, Germany and Italy for stocking inland fisheries and aquaria.

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Jan. 4.

[1] Nordmann, "Mik. Beitr.", 63 (1832).
[2] Gurney, R., "Brit. Freshwater Copepoda", 3 (Ray Soc., 1933).
[3] Scott, T., and Scott, A., "British Parasitic Copepoda", 2 vols. (Ray Soc., 1913).
[4] Schäperclaus, W., "Fischkrankheiten" (3rd edit., 1954).

Sporulation of Fungi inside the Plant Host Cell

The sporulation of fungi usually occurs when suitable conditions of nutrition and aeration are provided. It appears that whereas the conditions inside plant cells commonly admit of the formation of resting spores, they are, in general, less suitable for the formation of non-resting ones. Thus in Plasmodiophorales, the plasmodia develop into resting spores within the host cells, whereas the active swarm spores are typically formed outside the host. Again, in Pythiaceae, Albuginaceae and Peronosporaceae, the resting spores (zygotes) may be formed inside the host tissue; but the zoosporangia and conidia are usually formed outside it. The powdery mildews, smut and rust fungi, in different ways, exemplify this same phenomenon. So far as I know, conidia as defined by Mason[1] are rarely reported to be formed inside plant cells and, more particularly, at some depth in a tissue matrix. In these few cases where they have been reported, they typically occur inside the vessels, for example, microconidia of *Fusarium oxysporum cubense* inside the spiral vessels of banana plants[2], and the presence of microconidia of *Fusarium oxysporum conglutinans* has been described in the xylem of the cabbage plant[3]. It may be that it is not uncommon in the experience of pathologists to encounter conidia in plant cells; but the phenomenon does not appear to have been given much attention and it has not been dealt with in standard texts.

In the course of my present experimental work on fungal rots of potato tubers during storage, conidia of a pathogen were found inside host tissue. It was observed that a synergistic effect between *Rhizoctonia solani* Kühn and *Fusarium solani* sensu Snyder and Hansen resulted, under certain conditions, in the formation of pimple-like outgrowths. These 'pimples' were caused by the division and enlargement of the parenchymatous cells beneath the cork layers. The periderm also divided and enlarged to cover this tissue extension (Fig. 1). At a later stage, *F. solani*, proceeding from the inside of the tuber, invaded the pimples and sporulated abundantly inside the elongated parenchyma cells, but conidia were not

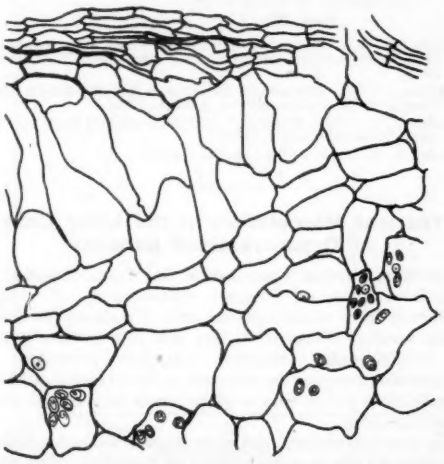

Fig. 1. A part of a 'pimple' showing the elongation of the parenchyma and cork cells, before fungus invasion. (× 100)

Fig. 2. A part of a 'pimple' after *Fusarium solani* invasion, showing hyphæ and microconidia inside the elongated cells. (× 250)

observed in other adjacent sub-superficial parenchymatous tissues. The conidia observed were mostly microconidia with a few macroconidia (Fig. 2). Measurements of conidia showed that those formed inside the host were significantly smaller than those formed on ten-day old cultures on potato dextrose agar.

The reason for the formation of conidia in the pimples and not in other parts of the plant is not known; but it may be correlated with the factor which stimulates the division of the cells. The low number of macroconidia and the smaller size of spores inside the cells may be due to different factors, among which light may be important[4].

I wish to express my thanks to Prof. C. W. Wardlaw, under whose supervision this work was done.

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Feb. 22.

[1] Mason, E. W., "Annotated Account of Fungi Received at the Imperial Mycological Institute" (Imp. Myc. Inst., Kew, Surrey, 1933).
[2] Wardlaw, C. W., "Diseases of the Banana and the Manila Hemp Plant", 41 (Macmillan and Co., London, 1935).
[3] Walker, J. C., "Plant Pathology", 253 (McGraw-Hill Book Co., New York, Toronto, London, 1950).
[4] Harter, L. L., *Amer. J. Bot.*, **26**, 234 (1936).

Nuclear Vacuolation in the Liver Cells of Depancreatized Baboons

Severe nuclear vacuolation has been observed in the liver cells of human diabetics[1–3], of infants suffering from malnutrition[2] and of patients suffering from various diseases[2–5], but has not been reported in experimental diabetes, whether produced by pancreatectomy or by alloxan in laboratory animals. The factors promoting nuclear vacuolation still await investigation.

In our laboratory, depancreatized baboons rapidly develop all the manifestations of diabetes. The blood sugar rises to more than 500 mgm. per 100 ml., accompanied by 2–3 gm. per cent of glucose in the urine and severe ketonuria. Diabetes in the baboon can be controlled by insulin.

Serial liver puncture biopsies performed by the technique previously described[3] have revealed that nuclear vacuolation does not occur in baboons in a variety of experimental situations. Within four days after withholding insulin from depancreatized baboons, however, some degree of nuclear vacuolation is to be found in the liver cells adjacent to the portal tracts and, by the end of the seventh day, almost all cells throughout the lobule contain abnormally vacuolated nuclei (Fig. 1).

When fully developed, the vacuolated nucleus is characterized by a thick nuclear membrane to which is adherent the still prominent nucleolus and a thin rim of chromatin. The vacuole is filled with glycogen and occasionally contains a small globule of sudan-positive material. The concentration of nuclear glycogen contrasts with the paucity of cytoplasmic glycogen. Indeed, the nuclear reactions observed in the liver cells of depancreatized baboons are unmistakably similar to those present in the livers of human diabetics.

Although the number of vacuolated nuclei can be reduced by the administration of insulin, once these nuclei have appeared in the livers of depancreatized baboons, some are always to be found whether or not the diabetes is eventually controlled. Indeed, even in man when diabetes is well controlled dietetically and with the aid of insulin, a few vacuolated nuclei have always been found in the liver.

The presence of vacuolated nuclei cannot be correlated either with the severity of the glycosuria or of the ketonuria. Apparently, in depancreatized baboons, deprivation of insulin for a minimum period of four days initiates a process which profoundly alters the structure of the liver nuclei. Once developed, insulin can reduce the number but cannot abolish completely the vacuolated nuclei. Apparently, such nuclei remain as a permanent stigma of a temporary but complete deprivation of insulin.

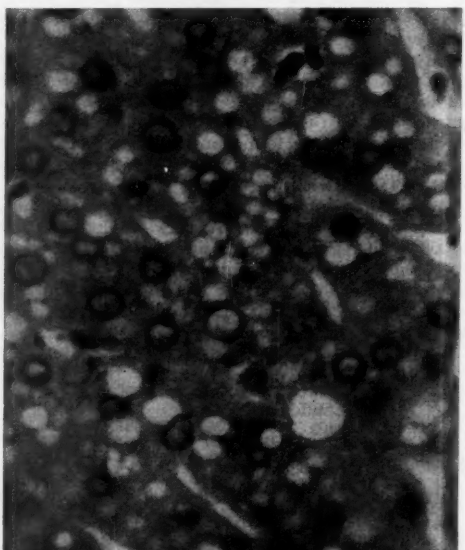

Fig. 1. Liver cells of depancreatized baboon showing numerous vacuolated nuclei each containing a large globule of glycogen

We wish to express our appreciation to Drs. J. C. Allan and A. J. Leonsins, of the Department of Surgery of this University, for depancreatizing the baboons.

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Dec. 2.

[1] Warren, S., "The Pathology of Diabetes Mellitus" (2nd edit., Lea and Febiger, 1938).
[2] Gillman, J., and Gillman, T., "Perspectives in Human Malnutrition", 238, 305 (Grune and Stratton, 1951).
[3] Cazal, P., and Mirouze, J., *Presse médicale*, No. 28, 571 (1951).
[4] Camain, R., from *Bull. méd. l'Afrique-occidentale française*, **9**, fasc. 2 (1952).
[5] Haex, A. J., de Jong, J. J., and van Beek, C., *Nederl. Tijdschr. v. Geneesk.*, **87**, 923 (1943).

Pseudo-Cholinesterase in the Central Nervous System of the Frog

A RECENT reference in the literature[1] suggests that there may be no pseudo-cholinesterase in the central nervous system of the frog. The conclusion is based on two kinds of evidence: (1) with Warburg manometric technique the tissue did not split significant quantities of benzoylcholine; and (2) there was evidently no splitting of butyrylthiocholine when the tissue was examined histochemically by Koelle's[2] modified technique. Our own evidence suggests that this conclusion is incorrect.

Many studies[3] have shown that benzoylcholine is for many species, notably the ruminants, not a suitable substrate for the demonstration of pseudo-cholinesterase. Butyrylcholine is for this reason the substrate to be preferred in comparative studies. Using butyrylcholine, one of us (D. C. H.) has found that frog tissue (homogenate of brain, spinal cord and sciatic nerve) can split butyrylcholine, and the results clearly suggest the presence of both true and pseudo-cholinesterase (see Table 1).

Table 1

Tissue	Substrate (10 m*M*)	μl./hr./mgm. tissue: No inhibitor	μl./hr./mgm. tissue: DFP 10^{-4} *M*
Brain	Acetylcholine	14·2	12·9
	Butyrylcholine	3·5	0
Spinal cord	Acetylcholine	18·4	14·6
	Butyrylcholine	7·3	0
Sciatic nerve	Acetylcholine	1·2	1·3
	Butyrylcholine	about 0·7	0
Mixed nervous tissue*	Acetylcholine	12·0	10·9
	Butyrylcholine	2·7	0

* Mixed tissue = combined brain, spinal cord and sciatic nerve.

Moreover, as mentioned earlier[4], it can be shown that sections of frog retina split butyrylthiocholine when the incubation system is that first described by Koelle[5]. Here, and in the spinal cord of the frog, the quantity of enzyme splitting butyrylcholine seems to be small; but it is demonstrable. An interesting finding is that both true and pseudo-cholinesterase may be present in the supporting cells of the optic nerve trunk.

These results underline the care required in attempting to characterize an enzyme by its activity towards one substrate only; this is particularly true of the use of benzoylcholine as a test for pseudo-cholinesterases, the specificity pattern of which varies markedly from species to species.

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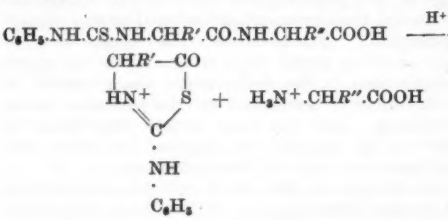
Dec. 8.

[1] Shen, S. C., Greenfield, P., and Boell, E. J., *J. Comp. Neurol.*, **102**, 717 (1955).
[2] Koelle, G., *J. Pharmacol.*, **103**, 153 (1951).
[3] Myers, D. K., *Biochem. J.*, **55**, 67 (1953). Mendel, B., and Myers, D. K., *Nature*, **176**, 783 (1955).
[4] Hebb, C. O., *Pharmacol. Rev.*, **6**, 39 (1954).
[5] Koelle, G., *J. Pharmacol.*, **100**, 158 (1950).

Mechanism of the Phenyl *Isothiocyanate* Degradation of Peptides

A STUDY of the mechanism of the phenyl *iso*-thiocyanate degradation of peptides[1] has made necessary a revision of our earlier formulation of this reaction. It has been found that the compound initially formed in the acid-catalysed cleavage of a phenyl thiocarbamyl peptide is not the expected 3-phenyl-2-thiohydantoin derivative of the N-terminal amino-acid, but instead the isomeric 2-anilino-5-thiazolinone.



This intermediate is clearly distinguishable from the thiohydantoin by its ultra-violet absorption curve (Fig. 1) and by its behaviour on paper chromato-

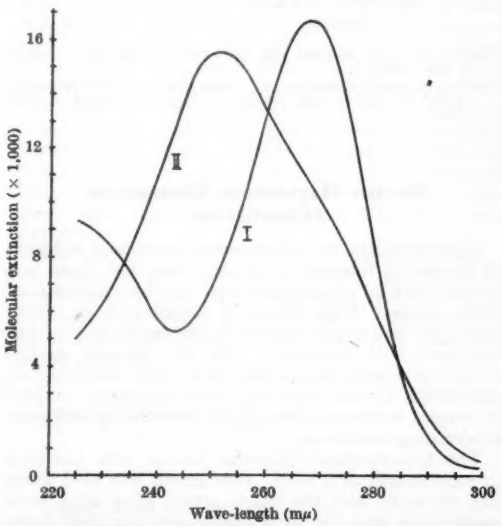
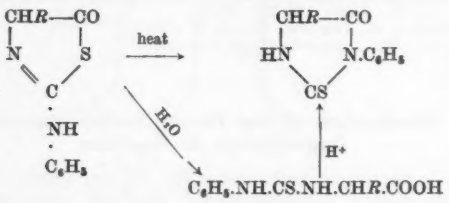


Fig. 1. Ultra-violet absorption curves of 5-*iso*butyl-3-phenyl-2-thiohydantoin (I) and 2-anilino-4-*iso*butyl-5-thiazolinone (II) in ethanol

graphy. Its marked instability explains why it has eluded discovery earlier. Thus, for example, recrystallization converts it to the isomeric 3-phenyl-2-thiohydantoin. Furthermore, it has been found that the thiazolinone can be converted to the thiohydantoin along two different routes. Under anhydrous conditions the conversion takes place as an intramolecular rearrangement, whereas in aqueous solution the thiazolinone is first rapidly hydrolysed to the phenyl thiocarbamyl amino-acid, which later slowly undergoes ring closure to the thiohydantoin.



This reaction mechanism offers an explanation for some discrepancies noted by several workers. Thus the remarkably large difference in the rate of cleavage of phenyl thiocarbamyl peptides in non-aqueous[1] and in aqueous acid solution[2] is only apparent, since in the latter instance the reaction observed was not the cleavage of the peptide, but actually the conversion of the phenyl thiocarbamyl amino-acid to the phenyl thiohydantoin. Furthermore, the appearance of multiple spots on paper chromatograms as the result of a single step in the degradation can probably in many instances be explained by the presence of the intermediates. For the same reason the extent of cleavage of the peptide may appear low when calculated from the yield of thiohydantoin.

A full account of this work will be published in *Acta Chemica Scandinavica*. It has been aided by a research grant from Eli Lilly and Company.

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[1] Edman, P., *Arch. Biochem.*, **22**, 475 (1949); *Acta Chem. Scand.*, **4**, 283 (1950).
[2] Ottesen, M., and Wollenberger, A., *Nature*, **170**, 801 (1952). Fraenkel-Conrat, H., and Fraenkel-Conrat, J., *Acta Chem. Scand.*, **4**, 1409 (1950).

Serum Magnesium Changes in Hibernation

Hypothermia and hibernation have been subjects of increasing interest in recent years, yet there is a critical lack of observations on the biochemistry of these states. High levels of magnesium in serum have been related by several investigators to hibernation and cold exposure[1]. In the present studies levels of serum magnesium and other electrolytes, and serum specific gravities, were compared in bats in several series including both hibernating and non-hibernating conditions.

The first species (*Eptesicus fuscus*) was collected in hibernation in a cave. One group was bled while still dormant and the other group after they were maintained and fed in a flight cage for four days. The second species (*Myotis lucifugus*) was obtained from a summer colony and from a cave in winter hibernation. The specimens were bled after periods of hibernation varying from 1 hr. to 9 weeks. The serum potassium determinations by flame photometry showed no significant changes due to hibernation. For other electrolytes recently described micro-methods were used; for the calcium, the method of Natelson and Penniall[2] and for magnesium the method of Orange and Rhein[3]. The serum calcium-level during hibernation decreased, whereas the cell/plasma ratio and the specific gravity of the serum increased slightly but not consistently. The serum magnesium in all hibernating groups was 50 per cent higher than in the active animals, which normally showed a level of 4·1 mgm. per 100 ml. P values ranged from 2 to less than 1 per cent. The specific-gravity results indicated this was not a passive process.

The increase of serum magnesium in bats occurred after only one to two hours of hibernation and was found by the time the œsophageal temperature had dropped to 13° C. There was no significant increase in serum magnesium when the œsophageal temperature had dropped to only 17–20° C. Awakening from hibernation does not require a lowering of the serum magnesium, since there was no reduction of serum magnesium when body temperature was raised to 18° C., a procedure which required 5–8 min. However, one hour after arousal from hibernation, the serum magnesium had dropped. The increase in serum magnesium in hibernation is uninfluenced by season.

This research was aided by grants from the Central Scientific Fund of the College of Medicine, State University of Iowa, and National Science Foundation, Washington, D.C.

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[1] Suomalainen, P., *Ann. Acad. Sci. Fennicae*, A, **53**, 1 (1939). Platner, W. W., and Hosko, M. J., *Amer. J. Physiol.*, **174**, 273 (1953). McBirnie, K. E., Pearson, F. G., Trusler, G. A., Karachi, H. H., and Bigelow, W. G., *Canad. J. Med. Sci.*, **31**, 421 (1935).
[2] Natelson, S., and Penniall, R., *Anal. Chem.*, **27**, 434 (1955).
[3] Orange, M., and Rhein, H. C., *J. Biol. Chem.*, **189**, 379 (1951).

The 'Seebeck Effect' in a Purely Ionic System

In a recent discussion of the transducing mechanism responsible for thermal sensibility, it was argued that, if the free nerve-ending and the extracellular fluid surrounding it could be regarded as a thermocouple, a single sensory mechanism could account for the sensations of 'warm' and 'cold'[1]. A calculation of the potential difference associated with temperature gradients in homogeneous electrolytic solutions indicated that a thermoelectric effect large enough to account for the depolarization of a nerve fibre would almost certainly have to arise at the interface between the two phases of such an ionic thermocouple. Such an effect, analogous to the Seebeck effect for metallic thermocouples, has not previously been demon-

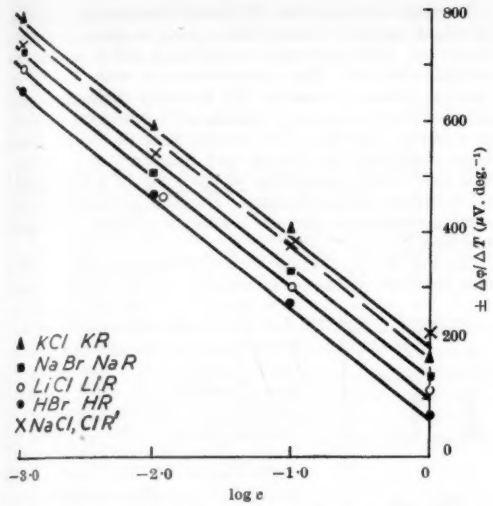

Fig. 1. Variation of $\pm \Delta\varphi/\Delta T$ with log e for cation-(R) and anion-(R') exchange resins. KR represent the cation resin in the potassium form, etc. The observed values of $\Delta\varphi/\Delta T$ were negative for the anion resin. The full and broken lines have the slope $2{\cdot}303\,R/zF$; the broken line refers to the anion resin

strated, so far as we are aware, for purely ionic systems. The following results show that the effect exists, and is of appreciable size.

As it was essential for the solid phase of the suggested ionic thermocouple to consist of an immobile framework of ions in which mobile ions of opposite sign are held, sheets of anion- and cation-exchange resins ('Permaplex *A* 10' and '*C* 10' respectively) prepared by the Permutit Co., Ltd., were selected. Strips of the resin 1 cm. wide, 0·5 mm. thick and 10–16 cm. long were bent into a U shape and covered with 56° C. paraffin wax to prevent loss of moisture by evaporation. The cell used for the cation exchange resin was:

$$\underset{T^0}{\mathrm{Ag,\ Ag}X} \;\Big|\; \underset{\text{conc. } C}{\text{Aqueous } MX} \;\Big|\; \underset{T^0}{\text{Resin in form}} \;\Big|\; \underset{T^0+\Delta T^0}{M^+} \;\Big|\; \underset{\text{conc. } C}{\text{Aqueous } MX} \;\Big|\; \underset{T^0}{\mathrm{Ag,\ Ag}X}$$

where X represents a halogen anion. The electrodes were introduced solely in order to make measurements of potential changes in the resin-electrolyte system possible, and made no net contribution to the e.m.f. developed by the cell. A similar cell was used for the experiments with the anion-exchange resins. The results were not intended to be precise; the main purpose of the work was the demonstration of the reality of the effect.

In general, the measured e.m.f., $\Delta\varphi$, was a linear function of the temperature difference ΔT across the strip, and the thermoelectric power $\Delta\varphi/\Delta T$ was reproducible for a given strip. Individual strips of the same nominal composition did not always show identical values for the thermoelectric power, probably because of slight differences in the concentration of the mobile ion in the solid phase. When the resins behaved reproducibly, the thermoelectric power of the cell was a logarithmic function of the concentration of the common ion (M^+ in the above cation-resin cel) in the electrolyte. This is seen in Fig. 1, where the experimental results are summarized. The values of $\Delta\varphi/\Delta T$ shown represent average values for this quantity over the range 20–55° C. and are accurate to about 0·02 mV. deg.$^{-1}$.

The variation of the thermoelectric power with the concentration of the common ion is of the form expected if the resin-solution interface is regarded as analogous to an electrode reversible to X^- or M^+ ions. On this model, the interfacial potential developed for unit change in T should change by approximately $2{\cdot}303\,R/zF$ for a ten-fold change in the concentration of the common ion in the electrolyte, where z represents the algebraic charge on this ion. If the cell illustrated is taken as an example, the electrode on the right would be positive if M^+ ions were released from the resin on heating, since the resin side of the interface would then become negatively charged. The converse should be true for a cell containing an anion-exchange resin. The straight lines in Fig. 1 show the theoretical value of the slope drawn as closely as possible to the experimentally determined points. There was, therefore, in these systems a contribution to the total thermoelectric power, dependent upon concentration, which arose at the resin-solution interface, that is, a contribution analogous to the Peltier e.m.f. in a metallic thermocouple. The remainder of the measured e.m.f. was made up of two thermal diffusion potentials (analogous to Thomson potentials) in the homogeneous phases in which temperature gradients existed, namely, in the resin strip and in the salt bridges. These were probably small in comparison with the effect at the interface; that in the electrolyte was probably of the order of tens of microvolts per degree.

If the mechanism of thermal sensation in free nerve-endings has any relation to this model system, a reasonable value for the thermoelectric power developed would be about 0·25 mV. deg.$^{-1}$. Changes in the nature of the solid phase could not change this value much. Since a voltage change of 10–15 mV. is required to initiate a propagated impulse in a wide variety of excitable tissues, it is improbable, therefore, that a single free nerve terminal could respond with the required sensitivity on the basis of this model. This does not necessarily rule out the hypothesis, since depolarization of an axon or cell body of nerve cells may be accomplished by the spatial or temporal summation of local depolarizations, individually or of a smaller magnitude than the minimum e.m.f. required for the 'triggering' of the parent axon or cell body. For the detection of a 1 deg. C. difference in temperature some forty to sixty locally propagated impulses of 0·25 mV. would be required to be summed at one stem nerve fibre to evoke a discharge. This is not an unreasonable number; in fact, many stem nerve fibres give rise to more than sixty nerve terminals.

We are indebted to Dr. T. R. E. Kressman, of the Permutit Co., for advice and for samples of the 'Permaplex' resins. The equipment used at Oxford was obtained with a grant to Dr. G. Weddell from the Rockefeller Foundation, which is gratefully acknowledged.

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[1] Tyrrell, H. J. V., Taylor, D. A., and Williams, C. M., *Nature*, **174**, 918 (1954).

Flame Spectrum of Barium: Red and Infra-Red Bands

The diffuse bands appearing very strongly in the flame spectra of the alkaline-earth metals have been identified as due to the hydroxide radicals, CaOH, SrOH and BaOH. This identification is based on the work of James and Sugden[1] on hydrogen–air flames, employing photometric methods, and on work on isotope shifts with deuterium, which have been obtained for CaOH by Gaydon[2] and for SrOH by Huldt and Lagerqvist[3]. The flame method has now been extended to the strong red and infra-red barium bands.

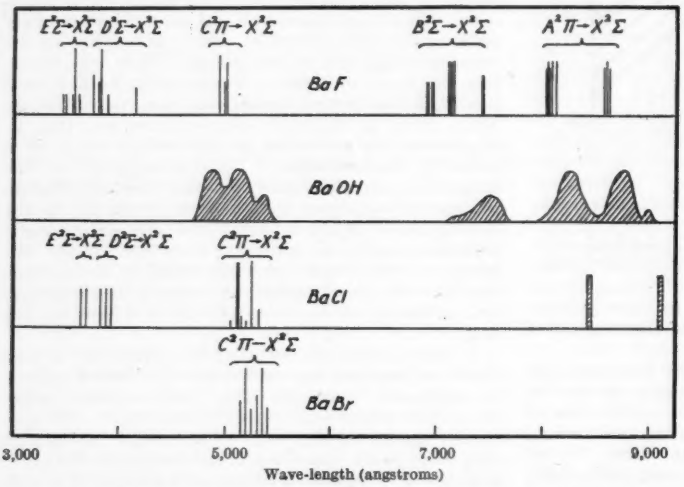

Fig. 1. Diagrammatic spectra of barium halide radicals, compared with the diffuse bands of barium flame spectrum

It has been pointed out by James and Sugden that there is a very marked similarity between the spectra of the alkaline-earth halide radicals and hydroxide radicals, the hydroxide falling between the fluoride and chloride. With calcium and strontium the green and orange and orange and red flame bands correspond to $B^2\Sigma \rightarrow X^2\Sigma$ and $A^2\Pi \rightarrow X^2\Sigma$ systems of the halide radicals. In the case of barium the blue-green bands correspond to the $C^2\Pi \rightarrow X^2\Sigma$ halide system. Bands analogous to the first two systems can be predicted to lie in the red and infra-red, in the region 7000–9000 A. It has been suggested by Huldt and Lagerqvist that barium flame bands lying at 8000–10,000 A. might be due to BaOH.

These bands were photographed, and the spectrum is represented diagrammatically in Fig. 1, together with the spectra of barium halide radicals as listed by Pearse and Gaydon[4]. It extends from about 7200 A. to 9000 A. (and probably beyond). The bands are all broad and diffuse and cannot possibly be confused with the red BaO bands, which show heads and are degraded to the red. The general appearance of these bands is exactly the same as of those in the blue and green, which are known to be due to BaOH. The resemblance between the distribution of the diffuse bands and BaF bands is very marked. It thus seems very probable that all the diffuse bands in the flame spectrum of barium arise from the same molecule, BaOH.

Further evidence was obtained from measurements of the integrated intensities, using a glass spectrometer of low resolution combined with a photoelectric device. The measurements were made in various flames, obtained by burning different mixtures of hydrogen and oxygen, with nitrogen diluent, in a Méker burner. The flames were of the shielded type, described by James and Sugden[5], and barium was introduced into them in the form of a fine spray of a dilute salt solution. The flame temperatures were measured by the sodium *D*-line reversal method.

In Fig. 2, $\log_{10} I_{band}$ is plotted against $1/T°$ K. for the red and infra-red bands, the green BaOH band (λ approx. = 5150 A.) being included for comparison. The experimental points do not lie on smooth curves but are grouped into 'families' of four, characterized by different nitrogen-to-oxygen ratios in the pre-burned gases. This effect illustrates the dependence of the concentration of the emitter on the composition of the flame, and it is practically the same for the three bands considered. (The accuracy of the measurements decreases towards lower temperatures.) Very similar results are obtained for the corresponding bands in the spectra of calcium and strontium. In all cases the dependence of band intensity on flame composition is characteristic, and so the red and infra-red BaOH bands fit very well into the general scheme of hydroxide radical bands. It will be recalled that it was on the basis of measurements made on the band intensities in isothermal flames that James and Sugden originally identified the strongest features of the alkaline-earth flame spectra as due to hydroxide radicals.

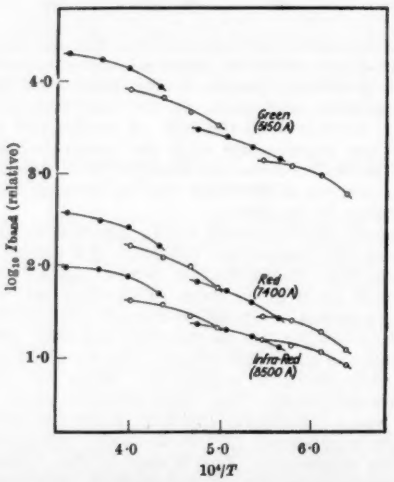

Fig. 2. Intensities of BaOH bands in various flames

I am grateful to Dr. T. M. Sugden for his advice and encouragement, and to Girton College and the Ministry of Education for a studentship.

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[1] James, C. G., and Sugden, T. M., *Nature*, **175**, 333 (1955).
[2] Gaydon, A. G., *Proc. Roy. Soc.*, A, **231**, 437 (1955).
[3] Huldt, L., and Lagerqvist, A., *Naturwiss.*, **42**, 365 (1955).
[4] Pearse, R. W. B., and Gaydon, A. G., "The Identification of Molecular Spectra" (2nd edit., Chapman and Hall, London, 1950).
[5] James, C. G., and Sugden, T. M., *Nature*, **171**, 428 (1953).

Infra-red Spectra of Chelating Agents: 2-Phenacylpyridine Derivatives

It has been suggested that in a conjugated system of the type (I), where XH and Y can form a hydrogen bond donor–acceptor system, there is a significant contribution of the ionic form (II) to the ground state of the chelate system.

(I) (II)

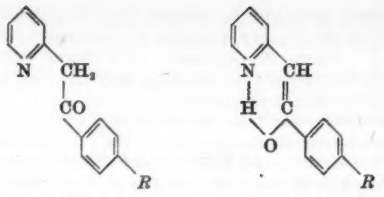
This phenomenon has been termed 'conjugate chelation', and has been observed to occur in acetylacetone, enolizable cyclic β-keto esters, in partially fluorinated β-diketones, in 2-acetyl-1-hydroxy naphthalene and related compounds, in 1-hydroxy anthraquinones, in flavanones and in ortho hydroxy aromatic aldehydes and ketones. All these compounds belong to the type (I) where X and Y represent oxygen atoms, but they fall into two classes. On one hand, there are the aliphatic and alicyclic materials, in which the double bond plays no part in any resonant system other than the chelate ring; and on the other hand are the aromatic compounds where the enol double bond is involved in an additional resonant system.

The systems mentioned above are characterized by carbonyl absorptions which are of increased intensity and widely shifted from the normal position. Furthermore, the hydroxyl absorptions are weak and diffuse, and so greatly shifted from the normal position as to indicate extremely strong hydrogen bonding.

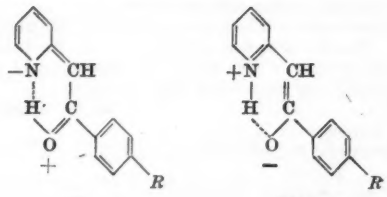
As part of a general investigation into the infra-red spectra of chelating agents and metal chelates, some derivatives of 2-phenacylpyridines[1] have been examined. These compounds, which are of interest because of their possible bacteriostatic activity[2], are now shown to represent another class exhibiting conjugate chelation.

All the compounds were examined as solid mulls in 'Nujol' and as solutions in chloroform, carbon tetrachloride or bromoform. The spectra were obtained with a Perkin–Elmer double-beam automatic recording spectrophotometer with a rock-salt prism.

The infra-red spectrum of 2-phenacylpyridine (III, $R = H$) in the solid state does not show an absorption in the position normal for a carbonyl which is conjugated with an aromatic ring (1,700–1,680 cm.$^{-1}$)[3], and neither can any hydroxyl absorption be observed. In chloroform or carbon tetrachloride solution, however, where an equilibrium



(III) (IV)



(V) (VI)

between the keto and enol forms exists, a very weak, diffuse hydroxyl absorption can be observed in the anomalous position of 2,600 cm.$^{-1}$. It can be concluded, therefore, that not only does 2-phenacylpyridine exist, in the solid state, in the enol form (IV, $R = H$), but also that the intramolecular hydrogen bond is greatly strengthened by resonance stabilization with the ionic forms (V, $R = H$ and VI, $R = H$) (cf. resonance stabilization of carboxylic acid dimers, C. A. Coulson, "Valence", p. 303).

Similar results were obtained from a series of 2-phenacylpyridine derivatives (see Table 1), with the exception of the hydroxy- and amino-compounds, which show a normal carbonyl absorption, and exist in the keto form in the solid state. It is significant that the hydroxy- and amino-groups have the largest negative Hammett σ values of the various substituents in Table 1, but it should also be noted that these two groups offer alternative hydrogen donors for hydrogen-bond formation.

The compounds listed in Table 1 show only two bands in the out-of-plane C—H deformation vibration region, and these can be assigned to the pyridine ring substituted in the α-position and the para di-substituted benzene ring. In each of the compounds which exists in the enol form (and where conjugate chelation occurs), the benzene and pyridine ring absorptions are constant, but situated at the extremes of the normal ranges. In the hydroxy- and amino-compounds, however, the frequencies are not constant, but appear in expected positions. Furthermore, both the benzene- and pyridine-ring absorption bands appear as doublets, or undergo considerable shifts, when these compounds are examined in

Table 1. Out-of-plane C—H Deformation Frequencies of 2-Phenacylpyridine Derivatives

Compound	Hammett σ value of substituent*	Pyridine ring vibration frequency (cm.$^{-1}$)	Benzene ring vibration frequency (cm.$^{-1}$)
2-*p*-Bromophenacylpyridine	+ 0·232	741	800
2-*p*-Chlorophenacylpyridine	+ 0·227	741	800
2-*p*-Fluorophenacylpyridine	+ 0·062	738	803
2-*p*-Methylphenacylpyridine	− 0·17	741	800
2-*p*-Methoxyphenacylpyridine	− 0·268	738	803
2-*p*-Hydroxyphenacylpyridine	− 0·357	756	822
2-*p*-Aminophenacylpyridine	− 0·660	763	833

* Jaffe, *Chem. Rev.*, **53**, 191 (1953).

bromoform solution in which both the keto- and enol-forms exist. (Bromoform is transparent in this region.) There is normally very little difference between the spectra of the solid and the solution for these particular frequencies.

This observation is of interest in view of the attention currently being given to the relation between polarity and infra-red frequencies[4]. These results also indicate that it may be possible to study keto–enol tautomerism in these cases in the low-frequency region which possesses the advantages of being fairly clear and containing strong bands.

Further work on these compounds will be published later. Thanks are due to Drs. A. H. Beckett and K. A. Kerridge, of the School of Pharmacy, Chelsea Polytechnic, for providing the samples.

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[1] Beckett and Kerridge, *J. Chem. Soc.*, 2948 (1954).
[2] Beckett, Kerridge, Patricia Clark, and Smith, *J. Pharm. Pharmacol.*, **7**, 717 (1955).
[3] Bellamy, "Infra-red Spectra of Complex Molecules" (Methuen, London, 1954).
[4] Bellamy, *J. Chem. Soc.*, 2818 (1955).

Photoelectric Phenomena with Copper Phthalocyanine

On the evidence of the dependence of electric conductivity upon temperature, Eley[1] and Vartanyan[2] reached the same conclusion, namely, that both phthalocyanine and its metallic derivatives should be regarded as kinds of semiconductors. In this connexion we wish to report that copper phthalocyanine exhibits the following photoelectric phenomena: (1) photoconductivity, (2) generation of electromotive force, and (3) change of the surface potential, both (2) and (3) being induced by illumination.

Experiments were conducted *in vacuo* at room temperature, employing crystal films prepared by vacuum sublimation. The light sources were a tungsten filament lamp, and mercury and sodium vapour lamps. Suitable filters being employed, whenever necessary, it was ascertained that the photoelectric phenomena occurred upon the illumination with ultra-violet or near infra-red as well as with visible light.

Conductance was measured by means of a surface cell. The organic crystal was deposited by sublimation on the surface of a quartz plate between the two gold electrodes of the cell. Photocurrents obey Ohm's law within the range studied (up to 100 V./cm.), and are proportional to the square roots of the light intensities.

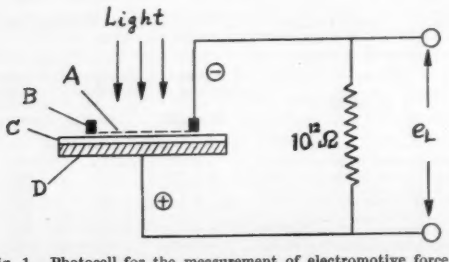

Fig. 1. Photocell for the measurement of electromotive force. *A*, translucent gold film; *B*, metallic ring; *C*, specimen film; *D*, platinum disk

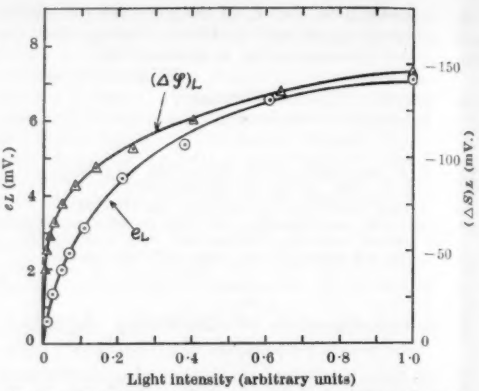

Fig. 2. The terminal voltage e_L and the change of surface potential $(\Delta S)_L$ plotted against light intensity (tungsten filament lamp

The cell used in measuring the electromotive force was of the sandwich type; that is, the crystal to be tested was first deposited on the surface of a platinum disk and then a thin translucent film of gold was prepared by evaporation upon the organic crystal (Fig. 1). When the photocell was illuminated without imposing any external voltage, an electromotive force was generated, and the film of gold became negative. In Fig. 2 the terminal voltage e_L induced by the illumination is plotted against the light intensity.

The surface potential was measured with a vibrating capacity electrometer. The fixed electrode was a platinum disk covered with the organic film. There occurred a distinct change upon illumination in the surface potential of the crystal film. The photoelectric effect of this experiment was of the same nature as found in the usual inorganic semiconductors such as germanium[3] and in organic dyes such as crystal violet[4]. The relation between the change of surface potential (ΔS_L) and the light intensity is also shown in Fig. 2.

These photoelectric phenomena are possibly due to the creation of mobile charges (electrons or positive holes) by the illumination, so that they should all be related to one another. They are certainly evidence of the semiconducting character of copper phthalocyanine. Similar phenomena have also been observed in our laboratory in crystals of metal-free phthalocyanine.

Details of the work described above will be published elsewhere. We thank Prof. K. Higasi for his interest and encouragement.

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[1] Eley, D. D., *Nature*, **162**, 819 (1948). Eley, D. D., Parfitt, G. D., Perry, M. J., and Taysum, D. H., *Trans. Farad. Soc.*, **49**, 79 (1953).
[2] Vartanyan, A. T., *J. Phys. Chem. U.S.S.R.*, **22**, 769 (1948); *Chem. Abstr.*, **43**, 1272 (1949).
[3] Brattain, W. H., and Bardeen, J., *Bell Syst. Tech. J.*, **32**, 1 (1953).
[4] Baba, H., and Nitta, K., *Bull. Res. Inst. App. Elec., Hokkaido Univ.*, **7**, 10 (1955).

FORTHCOMING EVENTS

Monday, April 9—Tuesday, April 10

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (in the William Beveridge Hall, Senate House, University of London, London, W.C.1), at 9.30 a.m. daily—Symposium on "Applications of Infrared Spectroscopy".

Monday, April 9—Saturday, April 14

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2)—Convention on "Digital-Computer Techniques".

Tuesday, April 10

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. I. Downes: "Patents in Chemical Engineering".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (in the Large Chemistry Lecture Theatre of the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 6.30 p.m.—Meeting on "Plant Instrumentation": Dr. B. W. Bradford: "Progress in Plant Analytical Control Methods"; Dr. A. E. Martin: "The Sonic Gas Analyser"; Mr. D. A. Patient: "Automation in the Laboratory".

Tuesday, April 10—Thursday, April 12

FARADAY SOCIETY (in the Great Hall, The University, Nottingham)—General Discussion on "Membrane Phenomena".

Tuesday, April 10—Friday, April 13

INSTITUTE OF METALS (in London)—Spring Meeting.

Tuesday, April 10

(At the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Dr. Willis Jackson, F.R.S.: "Ferroelectrics—the Dielectric Analogue of Ferromagnetics" (May Lecture).

Wednesday, April 11

(At Church House, Great Smith Street, S.W.1), at 10 a.m.—Annual General Meeting. Major C. J. P. Ball: "The History of Magnesium" (Presidential address).

Wednesday, April 11

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Raymond Pickering: "The Pleistocene Geology of the South Birmingham Area". (Paper to be read by Prof. F. W. Shotton.)

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. J. Paton: "The Polar Aurora" (Symons Memorial Lecture).

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. W. Platt: "The Oil Industry—Its Place in the World and Its Future".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5.45 p.m.—Annual General Meeting; at 6 p.m.—Fourth and Final meeting of the series "Nutritional Requirements and Food Fortification".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the Restaurant Room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion meeting on "Complexones in Microchemistry". Opening Speakers: Mr. H. J. Cluley and Mr. C. Whalley.

Wednesday, April 11—Thursday, April 12

LABORATORY ANIMALS BUREAU (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 9.30 a.m. daily—Ninth Congress.

Wednesday, April 11—Friday, April 13

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (in the William Beveridge Hall, Senate House, University of London, London, W.C.1), at 10 a.m. daily—Symposium on "Epoxide Resins—Their Chemistry and Structure in Relation to Their Properties and Applications".

Thursday, April 12

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. H. Nutcombe Hume: "The Work of the Colonial Development Corporation" (Thomas Holland Memorial Lecture).

INSTITUTION OF CHEMICAL ENGINEERS (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. L. Wilson, Mr. P. A. White and Mr. J. G. Milton: "The Control, Conveyance, Treatment and Disposal of Radioactive Effluents".

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. A. Poliakoff: "Development of Transistor Hearing-Aids".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6 p.m.—Annual General Meeting. Mr. H. J. Bunker: "Microbiology in Industry".

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting of the INDUSTRIAL and SOCIAL PSYCHOLOGY SECTIONS, in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 7.30 p.m.—Prof. Ross Stagner (University of Illinois): "Recent Psychological Research in Industrial Relations".

Thursday, April 12—Friday, April 13

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (joint meeting with the LOW TEMPERATURE GROUP of the PHYSICAL SOCIETY, at the Clarendon Laboratory, Oxford)—Conference on "Low Temperature Crystallography".

SOCIETY OF LEATHER TRADES' CHEMISTS (in the Chemistry School, Pembroke Street, Cambridge), at 9.30 a.m. daily.—Symposium on "Vegetable Tannins".

Friday, April 13

LABORATORY ANIMALS BUREAU (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 9.45 a.m.—Symposium on "Infections of Laboratory Animals". Chairman: Prof. J. W. Howie.

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The University, Glasgow), at 11.30 a.m.—Scientific Papers.

INSTITUTE OF METALS (in the Weir Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1), at 2.30 p.m.—Prof. Erich Schmid (University of Vienna): "Electron Emission from Metals".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Prof. J. L. M. Morrison, Mr. B. Crossland and Mr. J. S. C. Parry: "Fatigue Under Triaxial Stress.—Development of a Testing Machine and Preliminary Results"; Mr. N. E. Frost and Mr. C. E. Phillips: "The Fatigue Strength of Specimens Containing Cracks".

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. F. W. J. Garton: "Determination of Isotopic Abundance by Emission Spectroscopy".

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. C. N. Kington: "Industrial Research for Small Firms, with special reference to the Role of Information Services".

Friday, April 13—Sunday, April 15

BOTANICAL SOCIETY OF THE BRITISH ISLES (in Tuke Hall, Bedford College, Regent's Park, London, N.W.1), at 10.15 a.m. daily—Conference on "Progress in the Study of the British Flora".

Sunday, April 15

Field Meeting in the neighbourhood of Hitchin, Hertfordshire.

Saturday, April 14

ASSOCIATION OF CLINICAL BIOCHEMISTS (joint meeting with the BIOCHEMICAL SOCIETY, in the Biochemistry Department, The University, Glasgow)—Papers and Demonstrations, including a Symposium on "Clinical Control of Electrolyte Deficiencies".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade A) IN THE ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT, primarily for physics, calculations and engineering science—The Secretary, Poplar Technical College, Poplar High Street, London, E.14 (April 14).

ASSISTANT LECTURER or LECTURER (with special qualifications in applied mathematics or theoretical physics) IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, University College of Wales, Aberystwyth (April 14).

ASSISTANT LECTURER or LECTURER (with special qualifications in either inorganic or physical chemistry) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (April 14).

CHEMIST (honours graduate, preferably with experience of spectrochemical equipment) for advisory work concerned mainly with trace elements in plant nutrition—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (April 14).

DIRECTOR (scientist or technologist of established reputation, with administrative experience) OF THE SCIENCE MUSEUM—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4575/56/1 (April 14).

ASSISTANT LECTURER (preferably female) IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (April 16).

LECTURER or ASSISTANT IN THE JOINT DEPARTMENT OF CHEMICAL TECHNOLOGY AND CHEMICAL ENGINEERING (University of Edinburgh and Heriot-Watt College)—The Assistant Secretary, The University, Edinburgh (April 16).

SCIENTIFIC OFFICER, Grade 3 (with a degree of high standard, with physics as a major subject, together with several years relevant research experience) IN THE DEFENCE STANDARDS LABORATORIES, Department of Supply, Maribyrnong, Victoria, Australia, for research in X-ray and gamma-ray physics—The Senior Representative (AP.53),

Department of Supply, Australia House, Strand, London, W.C.2 (April 16).

Forestry Officer (with a degree in forestry from a British university) for work on schemes for the planting of derelict pit heaps, tree preservation orders, felling licences, park layout, etc.—The County Planning Officer, 10 Church Street, Durham (April 18).

Lecturer (with a good honours degree) in Chemical Engineering—The Registrar, King's College, Strand, London, W.C.2 (April 18).

Assistant Lecturer in Biology—The Registrar, University College of North Staffordshire, Keele, Staffs (April 20).

Chemist (with an honours degree in chemistry or equivalent qualifications, and at least two years industrial experience) in the Technical Policy Branch of the Industrial Group of the United Kingdom Atomic Energy Authority, to assist in the preparation of long-term programmes covering all activities of the Industrial Group—The Recruitment Officer, U.K.A.E., Industrial Group Headquarters, Risley, near Warrington (April 20).

Engineers and Physicists (Experimental Officer grade) in the Rocket Propulsion Department, Ministry of Supply, Westcott, Bucks, for research and development on rocket motors and propellants; instrumentation and recordings; investigations on high speed flow and heat transfer problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.105/6A/BN (April 21).

Assistant Lecturer in Applied Mathematics—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (April 25).

Senior Lecturers, Lecturers or Assistant Lecturers in Botany, Organic Chemistry, Mathematics and Zoology, at the University College of Khartoum, Sudan—The Secretary, Inter-university Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 25).

Assistant Lecturers (Grade III) or Demonstrators (2) in Physiology—The Registrar and Secretary, The University, Bristol (April 27).

Aerodynamicist or Mathematician (with a first- or second-class honours degree or equivalent in engineering or mathematics, and preferably with experience in experimental aerodynamics), at the Ministry of Supply Royal Aircraft Establishment, Bedford, to work in a section responsible for full-scale aerodynamics research on helicopters—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.110/6A (April 28).

Assistant (with an honours degree in physics) in the Department of Natural Philosophy—The Assistant Secretary, The University, Edinburgh (April 28).

Lecturer (with special qualifications in mineralogy, including a working knowledge of X-ray techniques) in the Department of Geology—The Registrar, The University, Bristol (April 28).

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics, and subjects allied to chemistry and physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Lecturer, Grade III or Grade II (preferably with research interests in the field of high energy physics and theories of elementary particles), in the Department of Physics—The Registrar, The University, Bristol (April 30).

Lecturer or Assistant Lecturer in Philosophy at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

Lecturers or Assistant Lecturers in Botany and Zoology, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

Senior Lecturer (with a good honours degree, and preferably with experience in teaching overseas students) in Geography, at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (April 30).

Chair of Botany at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 7).

Lawrence Hargrave Chair of Aeronautical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 7).

Reader in Mechanical Engineering at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 7).

Lecturer or Assistant Lecturer in Organic Chemistry—The Registrar, The University, Leeds 2 (May 12).

Assistant Lecturer in Inorganic or Physical Chemistry—The Secretary, Queen's University, Belfast (May 15).

Research Assistant (with a degree of doctor of philosophy or equivalent research experience) to work in the Department of Applied Mathematics on quantum collision problems.—Prof. D. R. Bates, Queen's University, Belfast (May 15).

Lecturer (with a university degree in forestry and additional training and experience in forest zoology, or an honours degree in entomology (or zoology including entomology)) in Forest Zoology—The Assistant Secretary, The University, Edinburgh (May 31).

Scientific Assistant (with an honours degree in biological sciences, some knowledge of foreign languages and the ability to write correct English)—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (June 1).

Leverhulme Student for research in Chemical Engineering—The Registrar, Imperial College, London, S.W.7 (July 1).

Instructors (with a Ph.D. degree or equivalent) in the Department of Chemistry, for duties which will involve undergraduate lecturing in Inorganic, Analytical and Physical Chemistry, and laboratory demonstrating—Prof. C. A. McDowell, Department of Chemistry, University of British Columbia, Vancouver 8, B.C., Canada.

Laboratory Technician (with some chemical experience)—Prof. F. C. Happold, Department of Biochemistry (University of Leeds), 9 Hyde Terrace, Leeds 2.

Master to take Physics up to University Entrance standard—The Headmaster, Keswick School, School House, Keswick, Cumberland.

Research Assistant (Ph.D. standard) for work on the physical absorption of vapours on ionic crystals—Dr. F. C. Tompkins, F.R.S., Imperial College, London, S.W.7.

Technician (preferably with photographic and radiation experience) in the Physics Department, to assist in a radiation protection service—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report of the Chief Inspector of Factories for the year 1954. (Cmd. 9505.) Pp. 265. (London: H.M. Stationery Office, 1955.) 8s. net. [301

Air Ministry: Meteorological Office. Handbook of Weather Messages. Part 1: Transmission Schedules and Station Index Numbers. Second edition. (M.O. 510a.) Pp. xi+114. (London: H.M. Stationery Office, 1955.) 6s. net. [311

Catalogue of Nuclear Reactors, 1955. Prepared by Atomic Energy of Canada, Limited, Chalk River Project, with the co-operation of the Atomic Energy Research Establishment, Harwell, England. (AECL No. 220. CRR-590.) Pp. 60. (London: H.M. Stationery Office; Chalk River: Atomic Energy of Canada, Ltd., 1955.) 4s. 6d. net. [311

Aluminium Development Association. Information Bulletin No. 19: The Arc Welding of Aluminium. Pp. 92. (London: Aluminium Development Association, 1955.) 2s. 6d. [311

Memoirs of the Royal Astronomical Society. Vol. 67, Part 3: The Cambridge Radio Telescope. By M. Ryle and A. Hewish. A Survey of Radio Sources between Declinations −38° and +83°. By J. E. Shakeshaft, M. Ryle, J. E. Baldwin, B. Elsmore and J. H. Thomson. Pp. 13–154+plate 1. (London: Royal Astronomical Society, 1955.) 28s. [311

Aero Research Technical Notes. Bulletin No. 156: The Uses of Stickiness. Pp. 3. (Duxford: Aero Research Limited, 1955.) [311

Other Countries

Proceedings of the American Philosophical Society. Vol. 99, No. 6 (December 15, 1955): Studies on Benjamin Franklin (The Two Hundred and Fiftieth Anniversary of his Birth, January 17, 1956). Pp. iv+359–476. (Philadelphia: American Philosophical Society, 1955.) 1 dollar. [201

Académie Royale de Belgique. Classe des Sciences. Mémoires, Tome 29, Fascicule 3: Sur certaines classes d'espaces homogènes de groupes de Lie. Par J. Tits. Pp. 268. (Bruxelles: Académie Royale de Belgique, 1955.) 200 francs. [201

Henry N. Ridley, 1855–1955. (The Ridley Centenary, 10th December, 1955, Botanic Gardens, Singapore.) Pp. 16+1 plate. (Singapore: Botanic Gardens, 1955.) [201

Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Mathematik und Allgemeine Naturwissenschaften. Beiträge zur Tektonik des Thüringer Beckens. (Abhandlungen zur Geotektonik Nr. 5. Herausgegeben vom Geotektonischen Institut der Akademie.) Pp. 173+12 karten und profile. (Berlin: Akademie-Verlag, 1955.) 54 D. marks. [201

Institut Royal des Sciences Naturelles de Belgique. Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949). Résultas Scientifiques. Vol. 3, Fascicule 4: Larve de Cérianthaire. Par Eugène Leloup. Siphonophores. Par Eugène Leloup. Crustacés Décapodes, Paguridea. Par Jacques Forest. Some Opisthobranchs from West Africa. By Kathleen M. White. Alcyonaires Atlantiques Intertropicaux. Par Andrée Tixier-Durivault. Pp. 246 (6 plates). Exploration Hydrobiologique du Lac Tanganyika (1946–1947). Résultas Scientifiques. Vol. 4, Fascicule 2: Characeae. By Richard D. Wood. Hepaticae. Par Constant Vanden. Pteridophyta. Par Fernand Demaret. Compositae, Loeacese, Lemnaceae et Vitaceae. Par André Lawalrée. Pp. 82 (6 plates), (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1955.) [201

Possibilities of Action in the Field of Nuclear Research. (Working Party on Nuclear Energy.) Pp. 70. (Paris: O.E.E.C.; London: H.M. Stationery Office, 1956.) 300 French francs; 6s.; 1 dollar. [301

Smithsonian Miscellaneous Collections. Vol. 131, No. 4: New Cretaceous Brachiopoda from Arizona. By G. Arthur Cooper. Pp. 18+4 plates. (Publication 4227.) (Washington, D.C.: Smithsonian Institution, 1955.) [311

Companhia de Diamantes de Angola. Servicos Culturais. Dundo-Lunda–Angola. Museu do Dundo. Subsidios para o Estudo da Biologia na Lunda. Publicacoes Culturais No. 28: Preliminary Revision of the genus Catantops Schaum and Review of the Group Catantopini (Orthoptera, Acrididae). By Dr. V. M. Dirsh. Pp. 151. (Lisboa: Companhia de Diamantes de Angola, 1956.) [311

Memorie dell'Istituto Italiano di Idrobiologia "Dott. March da Marchi." Suppl. Vol. 8: Symposium on Biological, Physical and Chemical Characteristics of the Profundal Zone of Lakes, Pallanza, 21–24 Luglio 1954. (Colloque N. 19, I.U.B.S.) Pp. 530. (Milano: Editore Ulrico Hoepli, 1955.) [311

Bulletin d'Information de l'Institut National pour l'Étude Agronomique du Congo Belge. Vol. 4, No. 6 (Décembre 1955): La culture du tabac au Lomami. Par R. Van Leer. Pp. 357–416. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) [311